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TRANSPORTATION CONTROLS TO REDUCE MOTOR VEHICLE EMISSIONS IN SEATTLE, WASHINGTON

Fred Winkler

GCA Corporation

Prepared for:

Environmental Protection Agency

December 1972

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16. Abstracts

The document demonstrates the nature of the Air Quality problem attributed to motor vehicle operation, the magnitude of the problem and a strategy developed to neutralize these effects in order that National Ambient air quality standard may be attained and maintained.

17. Key Words and Document Analysis. 17a. Descriptors

Motor Vehicle emitted pollutants - air pollutants originating within a motor vehicle and released to the atmosphere.

National Ambient Air Quality Standards - Air Quality Standards promulgated by the Environmental Protection Agency and published as a Federal Regulation in the Federal Register.

17b. Identifiers/Open-Ended Terms

VMT - Vehicle Miles Traveled.
Vehicle Mix - distribution of motor vehicle population by age group.
LDV - light duty vehicle - less than 6500 lbs.
HDV - heavy duty vehicle - greater than 6500 lbs.

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EPA Project Officer: Fred Winkler

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ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Water Programs
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Research Triangle Park, North Carolina 27711

December 1972

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I. INTRODUCTION AND SUMMARY

A. BACKGROUND

States were required to submit implementation plans by January 30, 1972, that contained control strategies demonstrating how the national ambient air quality standards would be achieved by 1975. Many urban areas could not achieve the carbon monoxide and oxidant air quality standards by 1975 or even 1977 through the expected emission reductions from the 1975 exhaust systems control. Major difficulty was encountered by many states in the formulation of implementation plans that included transportation control strategies (including, for example, retrofit and inspection, gaseous fuel conversions, traffic flow improvements, increased mass transit usage, car pools, motor vehicle restraints, and work schedule changes). Because of the complex implementation problems associated with transportation controls, states were granted until February 15, 1973 to study and select a combination of transportation controls that demonstrated how the national air quality standards would be achieved and maintained by 1977.

B. PURPOSE, SCOPE AND LIMITATIONS OF STUDY

The purpose of the study reported on herein was to identify and develop transportation control strategies that will achieve the carbon monoxide and oxidant air quality standards required to be met by the State of Washington in the Seattle urban area by the year 1977. As part of the study, calculations of motor vehicle emissions were also carried

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out for central areas of Tacoma and Everett. The results of the study were to help determine the initial direction that the State of Washington should take in selecting feasible and effective transportation controls. It was anticipated that the control strategies outlined in this study would be periodically revised in the coming years. The State's Implementation Plan was analyzed to verify and assess the severity of the carbon monoxide and oxidant pollutant problems, and the most promising transportation controls and their likely air quality impact were determined. Major implementation obstacles were noted after discussions with those agencies responsible for implementing the controls, and finally, a surveillance review process (January, 1973 - December, 1976, inclusive) was developed for EPA to use in monitoring implementation progress and air quality impact of transportation control strategies.

It should be noted that the study was carried out relying on the best data and techniques available during the period of the study and further, that a large number of assumptions were made as to the nature of future events. The 1977 air quality predictions were based on extent air quality data and on predicted stationary source emissions and predicted traffic patterns, and these predicted parameters themselves were based on anticipated emission control techniques, anticipated growth patterns, and the assumed outcome of unresolved legal and political decisions. Further, the development, ranking and selection of transportation controls were based on extant and predicted economic, sociological, institutional and legal considerations. Finally, the surveillance process presented in this report, although showing key checkpoints towards implementation of the recommended controls, is in itself dependent upon the same assumed pattern of future events.

It should be emphasized therefore, that to the extent that the time-scale of the recommended program permits, the conclusions and recommendations of this report should not be construed as a program which must be rigidly followed until 1977, but rather it should be regarded first, as a delineation as to what appears at the present time to be a feasible course of action to attain air quality goals, and secondly, as a framework upon which an optimum on-going program can be built as new data and techniques become available, as legal and political decisions are made, and as the assumptions as to future events are, or are not, validated.

C. CONTENT OF REPORT

Section II of this report describes how the pollutant concentration levels which could be expected to occur in 1977 in the Seattle area were predicted. These levels were determined by an adaptation of the proportional model using motor vehicle emissions from traffic patterns predicted for 1977 together with predicted non-vehicular emissions for 1977 obtained from state agencies. Comparison of these predicted 1977 air pollutant concentrations with the national air quality standards enabled the computation of the motor vehicle emissions which would result in the air quality standards being met, and therefore, to what extent, if any, reductions in the predicted 1977 motor vehicle emissions would be required. In order to determine the pollutant concentration(s) which was to serve as the basis for the proportional model, an intensive evaluation of all existing meteorological and air quality data was performed. The final determination as to the concentration value used was made in close cooperation with representatives of local and state agencies and of EPA.

Section III describes how candidate control strategies were developed, evaluated and ranked having regard to technical, legal, institutional, sociological and economic criteria. An important feature of this task was the continuing interaction between, on one hand, the GCA study team, and on the other hand, representatives of local and state environmental planning and transportation agencies, concerned citizen's groups, and EPA representatives.

Section IV presents the rationale for selecting the optimum package of controls necessary to achieve the required reduction in motor vehicle emissions and also presents the confirmed effect on air quality.

Section V deals in detail with the obstacles to the implementation of the selected strategies. Since the obstacles to implementation were important criteria in the evaluation of the feasibility of candidate transportation controls, there is considerable discussion on such obstacles in earlier sections.

Section VI presents the surveillance review process which will enable EPA to monitor the implementation progress and air quality impact of the recommended strategies. Curves showing predicted air quality levels for the years 1973 to 1977 and beyond are presented, based on the Federal Motor Vehicle Control Program alone, and on the federal program in conjunction with three recommended transportation control strategies. These curves indicate the rate at which air quality should improve as time passes and as controls are implemented. In addition, important checkpoints are provided delineating the salient actions which must be taken in order to implement the strategies.

It should be noted, however, that the surveillance process thus provided is of necessity based on the problem, and the concomitant transportation controls as they are presently perceived. An equally important part of any surveillance process is the continuing reassessment of both the problem itself and the appropriateness of the required controls. As was discussed earlier in this Introduction, the present study employed a whole range of both of extant data and techniques, and also of assumptions about the course of future events. This data base should be continuously reviewed as new information becomes available. Thus, although the key background parameters are called out in the Surveillance Process, a thorough and continuing review of all the data, techniques and assumptions contained in this report will be required to properly update the problem definition and appropriate control measures.

D. SUMMARY OF PROBLEM AND REQUIRED TRANSPORTATION CONTROLS

The analysis described in the body of this report indicates a need for transportation control strategies to reduce CO emissions within Seattle's central business district if the national 8-hour average standard for CO concentration is to be met by 1977. On the other hand, the available data indicate that the oxidant standard and the 1-hour average

CO standard will be met throughout the urban area by means of the Federal Motor Vehicle Control Program alone. This assessment is based on recently acquired data and is somewhat at variance with the assessment made in the Implementation Plan which was based upon air quality measurements made in 1970 near a major freeway and indicated that both CO and oxidant problems would still be present in Seattle in 1977 unless transportation control strategies were adopted.

After evaluating a large number of possible controls, three strategies are recommended for implementation. They are:

(1) METRO Transit development
(2) Fringe parking with Personalized Rapid Transit (PRT)
(3) Improved downtown signal system

These three strategies together provide about one-third of the reduction in emissions required to meet the national 8-hour standard. The remaining reduction can be achieved through strategies which directly limit emissions from operating vehicles, such as retrofit, gaseous conversion of fleet vehicles and inspection, or by strategies which eliminate older vehicles from the CBD. A table of 1977 emissions by model year and vehicle type is included in Section IV to facilitate selection of a workable combination of these strategies. The single strategy of excluding all pre-controlled vehicles from the CBD, in conjunction with Strategies 1, 2, and 3 above, is judged to be just sufficient. A margin of safety can be introduced by means of additional strategies, if desired. The general use of retrofit systems with the requisite annual inspection and maintenance program, results in reductions considerably greater than required, but is not looked upon with favor by the State of Washington at the present time.

Table I-1 summarizes the CO problem and the cumulative effects of Strategies 1, 2, and 3 plus the exclusion of pre-controlled vehicles. It is emphasized again that the air quality estimates are "best estimates" based on available data and the proportional model. Also, experience shows that considerable variation in the maximum (or second highest) 8-hour concentration will be experienced at a given sampling location from year to year even under relatively constant emission rates. Finally, in addition to the temporal variation in air quality at a given station, substantial spatial variations are to be expected within the CBD. The predicted concentrations are presented in tenths of a part per million simply to indicate the anticipated overall trend in air quality.

The analysis of hydrocarbon emissions indicated that emissions from motor vehicles will decrease by 51 percent between 1971 and 1977 as a result of the Federal Motor Vehicle Control Program and that total emissions of hydrocarbons in the 23 square mile central zone of Seattle will be 16 percent below the allowable level in 1977. Use of the oxidant data used in the Implementation Plan, however, indicates the need for an additional reduction in vehicular emissions of 6.6 percent.

TABLE I-1

SUMMARY EMISSION AND CO AIR QUALITY DATA FOR SEATTLE CBD

	Without Strategies				With Strategies (1977)			
	1971	1977	1978	1979	METRO +	PRT +	Sig.Sys. +	Exclusion
a) Emission Densities (kg/8 hr/mi^2)								
Vehicular	14,301	8,175	6,951	6,001	8,032	7,875	7,579	6,275
Non-vehicular	292	292	292	292	292	292	292	292
Total	14,593	8,467	7,243	6,293	8,324	8,167	7,871	6,567
b) Air Quality (8-hr average in ppm)								
Observed (2nd highest)	20							
Estimated		11.6	9.9	8.6	11.4	11.2	10.8	9.0

c) Maximum Allowable Emission Level (kg/8 hr/mi^2)

Total	Non-Vehicular	Vehicular
6,567	292	6,275

d) Reduction in Vehicular Emissions from 1971 levels

	Percent
From Federal Motor Vehicle Control Program	43
Additional Required by Transportation Control Strategies	13

d) Reduction in Vehicular Emissions from 1977 "no strategy" level

	Percent
Required by Transportation Control Strategies	23

II. VERIFICATION AND ASSESSMENT OF AIR POLLUTION PROBLEM

A. OUTLINE OF METHODOLOGY

1. General

The basic procedure employed was to develop, for the urban area of Seattle, pollutant concentration levels which could be expected in 1977 without the application of transportation controls (the potential 1977 levels). Pollutant levels were determined by the proportional model using non-vehicular emissions supplied by state agencies and using vehicular emissions based on traffic data developed during the course of this study. More sophisticated techniques could not be employed due to the lack of suitable extant calibrated diffusion models, and the short time period of the contract which precluded the development of a suitable model and the required inputs. Comparison of potential 1977 air quality levels with the appropriate standard gave the allowable motor vehicle emissions in 1977, which in turn formed the basis for the development of transportation control strategies.

Emissions from non-vehicular sources were obtained from the State Implementation Plan. Emissions from vehicular sources were computed following the recommendations given in EPA draft publication An Interim Report on Motor Vehicle Emission Estimation by David S. Kircher and Donald P. Armstrong, dated October 1972. Air quality data for each sensor within the city area were reviewed and evaluated in close cooperation with state and local agencies. The instrumental method and sensor location was studied and records of instrument maintenance and calibration examined so as to identify questionable readings. Meteorological records were then examined and compared with seasonal and diurnal variations in air quality levels. Finally the pollutant concentration which would form the basis for the proportional rollback calculations was decided upon in concert with state and local agencies and EPA representatives. The year in which this concentration level occurred defined the base year for the proportional rollback calculations.

The detailed methodologies for carbon monoxide and oxidants are presented separately below.

2. Methodology for Carbon Monoxide

Because ambient concentrations of carbon monoxide at any given location appear to be highly dependent on carbon monoxide emissions in the near vicinity, it was felt that some justification existed for a modification of the proportional model. It was felt that in order to reduce ambient CO levels in, for example, a central business district (CBD), it would be more appropriate to roll back CO emissions in the CBD itself, rather than the entire air quality region. Accordingly, the Seattle urban area was divided into 32 one-mile-square traffic zones (one of these zones being identified as the CBD) and the assumption was made that pollutant concentration in each zone was directly proportional to the emission rate of the pollutant within that zone. Eighteen additional one-mile-square zones were defined for urban areas in Tacoma, Renton, Bellevue, Everett, and on Mercer Island.

The application of the proportional model, generalized for an urban area with multiple monitoring stations, comprises the following steps:

- Calculation of the total CO emission density (vehicular plus non-vehicular) for each zone in which CO concentrations are available for the baseline year. (In practice, baseline emission densities were calculated for all zones).
- Selection of the observed CO concentration for rollback computations at each monitoring station.
- Calculation of an emission density/concentration (e/c) ratio at each monitoring station.
- Calculation of the allowable emission density in each zone from the appropriate e/c ratio. (When measured e/c ratios differ from zone to zone, or within a single zone, the selection of an e/c ratio for general application is largely a matter of judgment.)
- Calculation of the total CO emission density for each zone for 1977 on the assumption that no transportation controls are imposed.
- Calculation, where required, of the reduction in emissions needed to meet the national air quality standard.

Although the principal contributing sources of CO to the urban area are motor vehicles, an attempt was made to apportion total CO emissions to vehicular and non-vehicular sources. Non-vehicular emissions for the years of interest were estimated from the State Implementation Plan which took into account predicted growth and predicted control strategies. The predicted control strategies were generally those that state agencies considered to be the maximum feasible, and therefore the predicted non-vehicular emissions were assumed to be irreducible for the purposes of this study. On the assumption that the predicted emission densities from non-vehicular sources were to be taken as irreducible, the allowable emissions from motor vehicles in each zone for the year of interest were then determined. For the purposes of evaluating the effects of candidate transportation controls, the maximum allowable emission density for the year 1977 was expressed as a percentage reduction from the 1977 "no strategy" emission density. However, as will be seen in following sections of this report, as each traffic control was developed, emissions were recomputed, using the revised VMT's and speeds resulting from the application of the control measures.

3. Discussion of Methodology for Carbon Monoxide

a. Modified Proportional Model

The applications and the limitations of the conventional proportional rollback method have been well documented and reviewed* and need not be discussed further here. The technique used in the present study was an extension of the conventional rollback technique to the extent that it was assumed first that the constant of proportionality between emissions and concentration may be derived from emissions emanating from the relatively small area around the sensor (the traffic zone), and second, that this constant of proportionality (the emission/concentration ratio) could be applied to determine pollutant concentrations in other zones of comparable area on the basis of the pollutant emissions in those zones.

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*Noel de Nevers. Rollback Modeling, Basic and Modified. Draft Document, EPA, Durham, N.C. (August 1972).

Some justification of the first assumption can be found, for example, in recent work of Hanna* and Gifford** who demonstrate the dominance of urban pollution patterns by the distribution of the local area sources. The success of their urban diffusion model, in which concentration is simply directly proportional to the area source strength and inversely proportional to wind speed, is attributed largely to the relatively uniform distribution of emission within an urban area and the rate at which the effect of an area source upon a given receptor decreases with distance. In the proportional model, meteorological effects, such as wind speed, are assumed to be duplicated over one-year periods. The validity of the second assumption depends, in large part, upon the extent to which diffusion and transport parameters are uniform from zone to zone - a factor which could not be investigated because of the constraints of the program. Thus, it was felt that, in the absence of a more sophisticated technique, the use of this extension to the proportional model was justified first, to obtain some assessment as to whether the existing sensors were located in the hot-spots, and second, to obtain some assurance that transportation strategies intended to reduce emission densities in one zone (to the level required to meet ambient standards) did not increase emission densities to unacceptable levels in adjacent zones. In many cities it was found that the sensors were, in fact, in the "hot spot" zones and also that the recommended transportation controls did not increase emissions in adjacent areas to unacceptable levels. Thus the final rollbacks were confined to the zones with a sensor within their boundaries and the extensions of the techniques to other non-sensor zones did not, therefore, play a primary role in the final computations.

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*Hanna, S.R., "A Simple Method of Calculating Dispersion from Urban Area Sources," J. APCA 21, 774-777 (December 1971).

**Gifford, F.A., "Applications of a Simple Urban Pollution Model," (paper presented at the Conference on Urban Environment and Second Conference on Biometeorology of the Amer. Meteor. Soc., October 31 - November 2, 1972, Philadelphia, Pa.).

Experience in urban areas that had several sensors showed that the emission concentration ratio differed substantially from zone to zone and served to underline the fundamental limitations of the technique employed. An implicit assumption in the technique employed was that the air quality in a traffic zone could be fairly represented by one concentration level and that this level depended only upon the average emission density within that zone. The two major factors mitigating against this assumption are:

(a) Emission densities are not uniform across even a small traffic zone.

(b) Concentration levels are not uniform across the traffic zone partly because of the lack of uniformity of emission density and partly because the point surface concentrations are affected by micrometeorology and microtopography as well as emission density.

Considerable judgment had to be used, therefore, both in the derivation of e/c ratios and in their subsequent use. In heavily trafficked downtown areas the variation was judged not to be too great, so that the single recorded concentration might reasonably be expected to be representative of the zone's air quality and emission density. However, in suburban zones having overall low traffic densities, sensors were often found to be placed at very localized hot spots, such as a traffic circle, so that the recorded concentration levels were neither representative of the overall air quality nor of the overall emission density in the zone.

Accordingly, e/c ratios were generally derived from sensors in the central areas of the cities and applied to suburban areas for the prediction of 1977 concentration levels. This procedure gave air quality levels which were generally representative of the suburban zone. However it must be realized that control strategies based on this procedure, while they may ensure that the overall air quality in a suburban zone will not exceed ambient standards, do not preclude the occurrence of higher concentrations in very localized hot spots such as might occur in the immediate vicinity of a major traffic intersection.

The analysis indicated that the Seattle CBD was the zone of maximum emissions and that the use of air quality data from the Municipal Building (located within the CBD) would provide a conservative approach to rollback calculations. The analysis also indicated that rollback would not be required in other zones. Thus, the final rollback calculations were confined to a single zone (the CBD) with a sensor within its boundaries.

b. Seasonal and Diurnal Variations

The CO observations at the Municipal Building showed that the 1-hour average concentration was much closer to the standard than the

8-hour average, so that controls required to meet the 8-hour standard would also result in the 1-hour standard being met. The diurnal variation of concentration at the Municipal Building showed clos correspondence to the daily traffic flow. Thus, strategies which reduce emissions over the extended daytime heavy traffic period should prove effective. Traffic data were not available on a seasonal basis, so vehicle emissions were based on annual average workday traffic data. Emission densities were calculated for the 8-hour period during the day with maximum traffic.

c. Background Concentration

Background concentration levels of CO were not taken into account. "Worst case" diffusion calculations indicated that the contribution of point sources upon the CBD could be safely neglected in the rollback calculations.

4. Methodology and Discussion for Oxidants

The technique employed for oxidants was basically the same as has just been described for CO with the major difference that only one, very much larger area, was used as the basis for the proportional rollback. Because of the length of time required for the formation of oxidants from hydrocarbon emissions, the relatively small areas used as the basis for CO could not be justified. The actual area used was largely a matter of judgement and comprised 23 square miles in the heart of Seattle.

The reductions in hydrocarbon emissions necessary to achieve oxidant ambient standards were obtained from Appendix J, Federal Register of August 14, 1971.

B. DISCUSSION OF 1970-1972 AIR QUALITY LEVELS

1. Natural Features Affecting Pollution Potential

a. Topography

Seattle, with a population in excess of one million, is located in the heart of the urbanized corridor of land which extends along the eastern shoreline of Puget Sound from Tacoma in the south to Everett in the north. Geographically, the Puget Sound area comprises a north-south basin lying between the Olympic Mountains to the west and the Cascade Mountain Range to the east. Mount Olympus rises to a height of nearly 8000 feet due west of Puget Sound, and numerous peaks of the Cascade Range east of the Sound extend above 8000 feet. Mount Ranier, with an elevation of 14,410 feet, lies approximately 60 miles to the south-east of Seattle. Seattle contains a number of low hills. It is bordered on the east by Lake Washington.

b. Meteorology

Because of the north-south orientation of the principal topographic features of the area, the prevailing winds are either from the south or from the north. Differences in wind direction within the area may be attributed to local variations in the terrain and to thermally driven mesoscale circulations. Land-sea breezes and mountain-valley winds tend to dominate the local circulation during periods of weak pressure gradient. Figure II-1, taken from the Implementation Plan, shows clearly the effect of different exposures on wind directions. The upper and lower wind roses

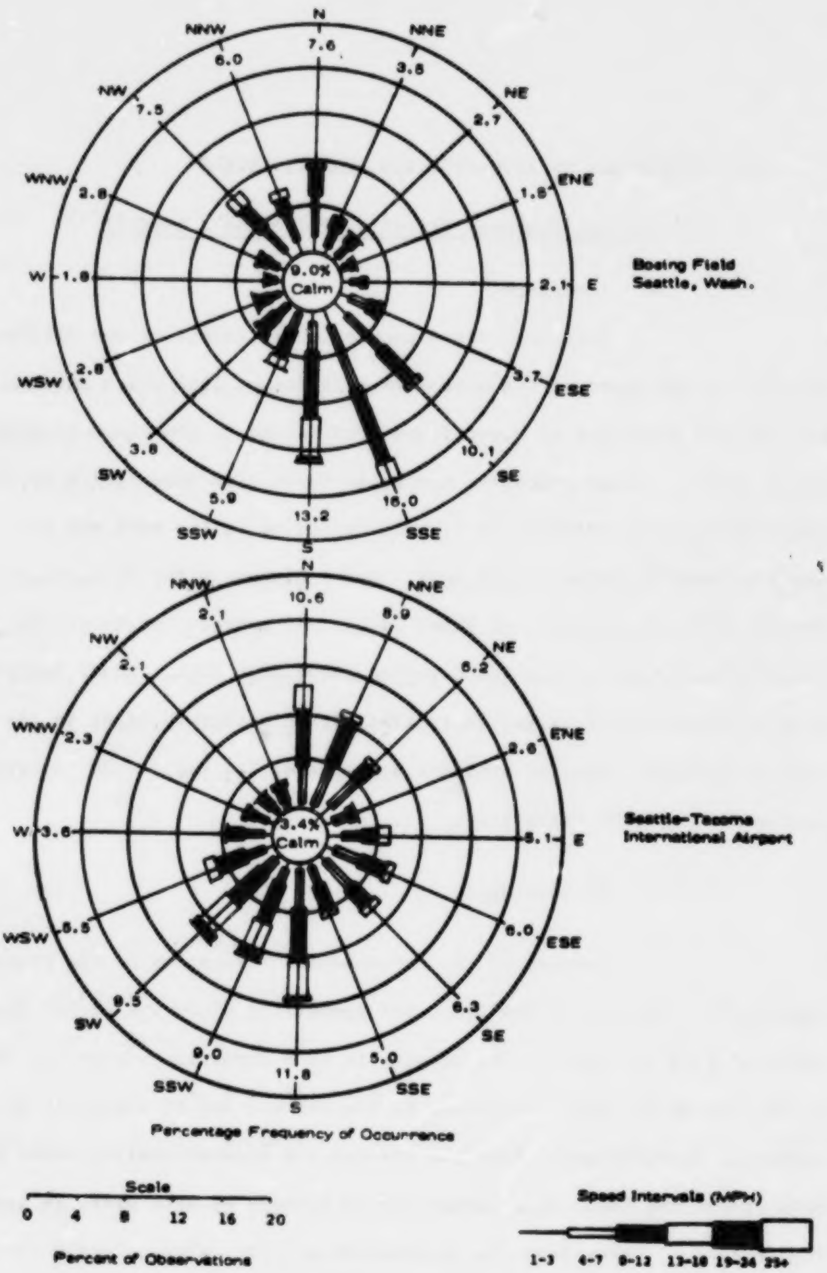

Figure II-1. Annual surface wind roses at two Seattle-Tacoma area airports for calendar year 1969.

were developed respectively from observations at Boeing Field, located in the north-northwest to south-southeast oriented Duwamish Valley, and at the Seattle-Tacoma (SEA-TAC) International Airport, located on a plateau southwest of the valley about 6 miles south of Boeing field.

During winter, the presence of a semi-permanent low-pressure area off the coast results in prevailing southerly winds over the Seattle region. The wind shifts briefly to the north following the passage of storms. In summer, the prevailing winds bring air from the Pacific through the Straits of Juan de Fuca to the northern part of Puget Sound, and from the Grays Harbor area south of Olympic Mountains to the southern part of Puget Sound. Typically, this results in a northerly flow which reaches the northern portions of King County, and southwesterly flow over the southern Puget Sound Area. As would be expected, the transition months of spring and fall exhibit circulation patterns found in both the winter and summer seasons.

Diurnal variation in wind direction is most pronounced during the summer season. Although the winds are predominantly northerly both day and night north of Seattle, a westerly component is evident during the daytime. Immediately south of Seattle, the daytime winds have a northerly component, while the nighttime winds are predominantly southerly.

Table II-1 gives the average mixing heights and mean wind speeds averaged through the mixing layer by season and time of day at the SEA-TAC Airport. These data are taken from Table B-1 of Mixing Heights, Wind

TABLE II-1

AVERAGE MIXING DEPTHS AND WIND SPEEDS AT SEA-TAC AIRPORT

A. Average Mixing Depths (m)

	Winter	Spring	Summer	Fall	Annual
Morning	626	681	532	476	578
Afternoon	585	1490	1398	898	1092

B. Average Mixing Layer Wind Speeds (m sec^{-1})

	Winter	Spring	Summer	Fall	Annual
Morning	5.1	4.6	4.0	4.3	4.5
Afternoon	4.7	5.7	4.8	4.6	4.9

Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States, by George C. Holzworth (Office of Air Programs Publication No. AP-101, EPA).

2. Monitoring Network

a. General

Monitoring for oxidants and CO in the Seattle region is carried out jointly by the Washington State Department of Ecology (DOE) and the Puget Sound Air Pollution Control Agency (PSAPCA). The responsibilities of each organization, the concepts used in designing the monitoring network, and details of network operation and data handling are covered in the Implementation Plan. Only details of particular relevance to the present study will be repeated here.

b. Type of Instrumentation

CO Analyzer - CO measurements are made by the EPA reference method (non-dispersive infrared spectrometry). The MSA units in use are operated continuously. They are calibrated by zero and span gas references every working day. Water discrimination is accomplished by silica gel drying columns changed three times each week.

Oxidant Analyzer - Oxidant measurements are made with Mast Ozone Meters. This instrument depends upon the oxidation of iodide to iodine and a subsequent coulometric reduction back to iodide for its operation. It detects all oxidants reducible by the iodide ion unlike the ozone-specific EPA reference method (chemiluminescence). The analyzers are equiped with SO_2 scrubbers to minimize interferences. Major maintenance and dynamic calibration are performed every six months.

c. Monitor Locations

Concentration measurements made at seven sites in the Seattle area during the period January 1970 - May 1972 were available for analysis. The period of observations at the individual sites ranged from two months to two years and five months. Table II-2 gives the 7 locations and specifies the period over which the pollutants were measured at each location. The approximate geographic location of the seven sites is given in Figure II-2.

3. Review of Air Quality Data

a. General

The CO and total oxidant concentrations observed at the seven monitoring stations during the periods listed in Table II-2 were reviewed in detail. The inclusion of data collected since submission of the Implementation Plan is believed to increase substantially the reliability of the baseline concentrations used in projecting air quality and estimating rollback requirements.

b. CO Air Quality Data

Table II-3 gives the highest 1-hour average concentration observed at each site during each month of the sampling periods. The national standard of 35 ppm was reached or exceeded once at I-5 and Dearborn (in Oct. 1970) and once at the Municipal Building (in Feb. 1972).

TABLE II-2

SUMMARY OF CO AND OXIDANT MONITORING FROM 1 JAN 1970 TO 31 MAY 1972

Site Name	Address	Agency	Pollutants	Height Above Ground (ft)	Location	Period of Observations	Duration of Sampling Period (Months)
Food Circus	Seattle Center	DOE	CO, Oxidants	70	Above Roof	Jan 1970-May 1972	29
Smith Tower	506-2nd Ave.	DOE	CO, Oxidants	225	Out Window	Jan 1970-May 1970	5
I-5 & Dearborn		PSAPCA	CO, Oxidants	55*	Above Trailer	July 1970-Oct 1970	4
Westlake Mall	5th & Pine	PSAPCA	CO, Oxidants	15	Above Trailer	May 1971-Aug 1971	4
Municipal Bldg.	5th & James	DOE	CO	15	Side of bldg.	July 1971-July 1972	13
McMicken Hts.	So. 176, 42nd Ave. S.	PSAPCA	CO, Oxidants	15	Above Trailer	Apr 1972-July 1972	4
Duwamish	5th & Michigan	DOE	CO, Oxidants	30	Above Trailer	June 1972-July 1972	2

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*Approximately 32 feet above the north and southbound lanes of I-5.

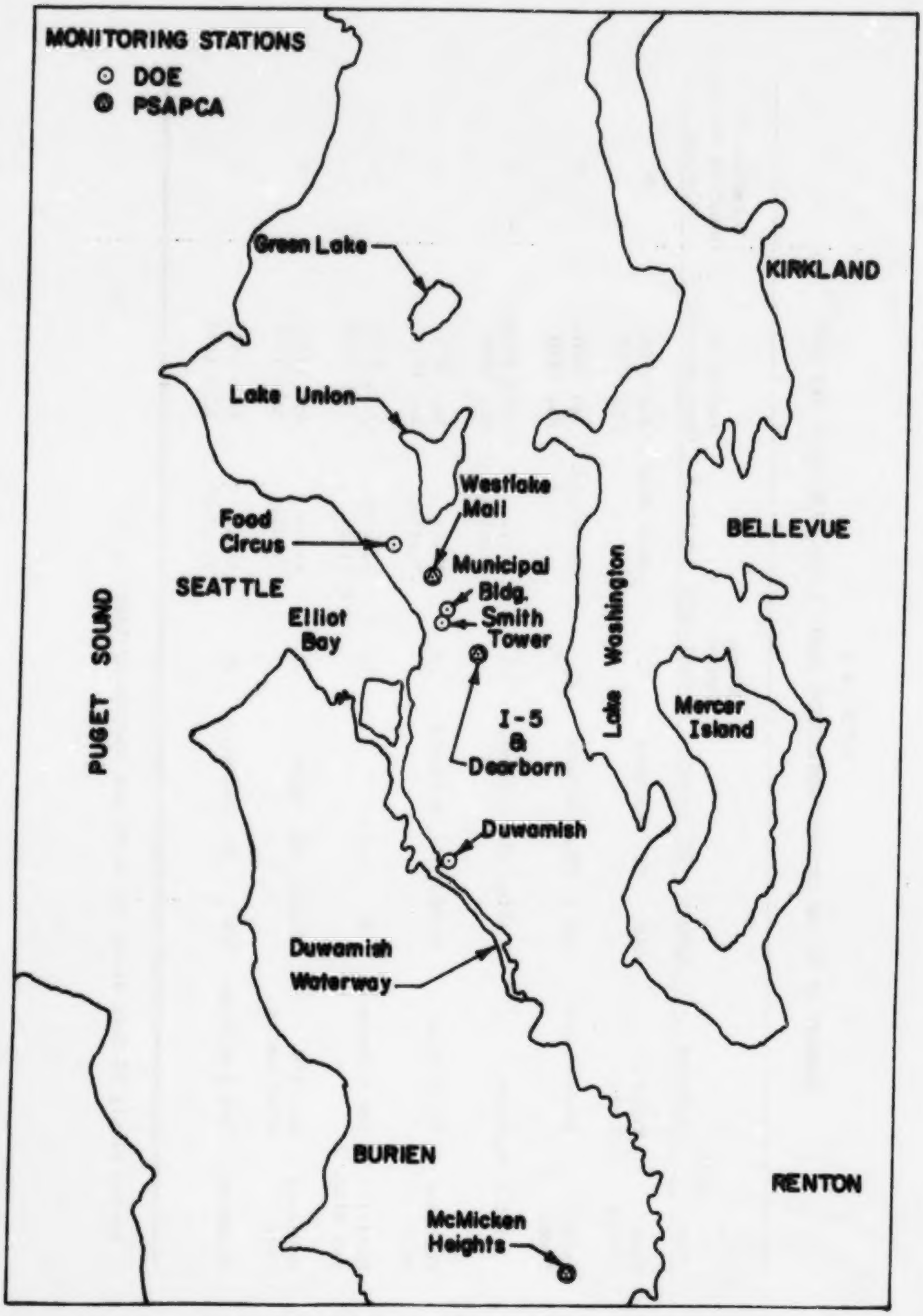
MONITORING STATIONS
⊙ DOE
◉ PSAPCA
Green Lake
KIRKLAND
Lake Union
Westlake Mall
Food Circus
Municipal Bldg.
Smith Tower
SEATTLE
Elliot Bay
PUGET SOUND
Lake Washington
BELLEVUE
Mercer Island
I-5 & Dearborn
Duwamish
Duwamish Waterway
BURIEN
RENTON
McMicken Heights

Figure II-2. Sketch of Seattle area showing locations of seven monitoring sites.

TABLE II-3

SUMMARY OF MAXIMUM 1-HOUR CO CONCENTRATIONS (IN PPM) AT SEVEN LOCATIONS IN THE SEATTLE AREA

		Monitor Location						
Year	Month	Food Circus	Smith Tower	I-5 & Dearborn	Westlake Mall	McMicken Heights	Municipal Building	Duwamish
1970	Jan	10	18					
	Feb	15	17					
	Mar	12	12					
	Apr	6	7					
	May	5	8					
	June	5						
	July	7		13				
	Aug	7		13				
	Sept	8		21				
	Oct	13		35				
	Nov	13						
	Dec	9						
1971	Jan	8						
	Feb	9						
	Mar	5						
	Apr	6						
	May	9			12			
	June	5			10			
	July	5			10		20	
	Aug	5			10		20	
	Sept	7					30	
	Oct	8					27	
	Nov	5					30	
	Dec	7					27	
1972	Jan	5					29	
	Feb	7					38	
	Mar	6					31	
	Apr	4				4	24	
	May	4				5	19	
	June					6	18	4
	July					5	20	4

The diurnal variations of CO concentration observed at the seven sites are shown in Figures II-3 through II-5.* Average seasonal curves at the Municipal Building are included in Figure II-3. At this location, high concentrations are consistently experienced during working hours in all four seasons. The concentration increases sharply to an early morning maximum at about 0800 local time, remains at high levels throughout the middle of the day, increases to the maximum for the day at about 1600 local time, and decreases abruptly thereafter to a fairly uniform evening level. As would be expected, the lowest concentrations are experienced between 0200 and 0500 local time, when traffic flow is at a minimum. The diurnal variations experienced at I-5 and Dearborn, Smith Tower, and at Westlake Mall (Figure II-4) are roughly similar to the diurnal variation at the Municipal Building, but the amplitudes of the curves are greatly reduced. Also, concentrations at I-5 and Dearborn remain relatively high throughout the evening. Concentrations at Duwamish, McMicken Heights, and Food Circus remain low at all times of the day. The seasonal variation between winter (January, February, and March) and spring (April and May) months at Smith Tower is pronounced, and separate curves are shown in Figure II-4 for the two seasons. Additional details of the diurnal and seasonal variations of CO concentration can be obtained from Tables II-4 through II-7 which give the highest 1-hour concentration observed during each hour of the day for each month at the various sites.

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*In these figures, and in Tables II-4 through II-7 which follow, average concentrations are entered in accord with the procedures of the monitoring agency. The PSAPCA records hourly average concentration as having occurred at the end of the averaging period, while the DOE records the hourly average concentration as having occurred at the beginning of the period.

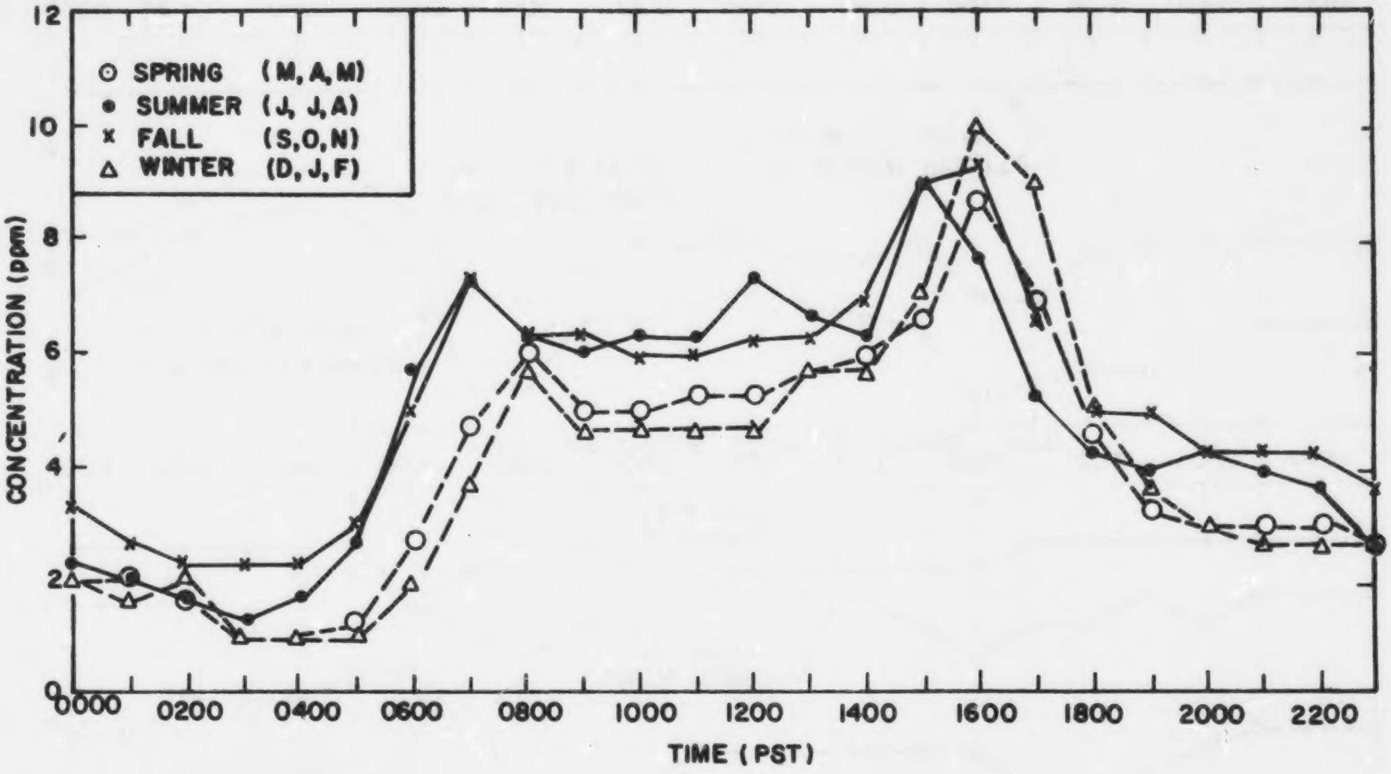

Figure II-3. Diurnal variation of CO concentration at the Municipal Building, Seattle, by season.

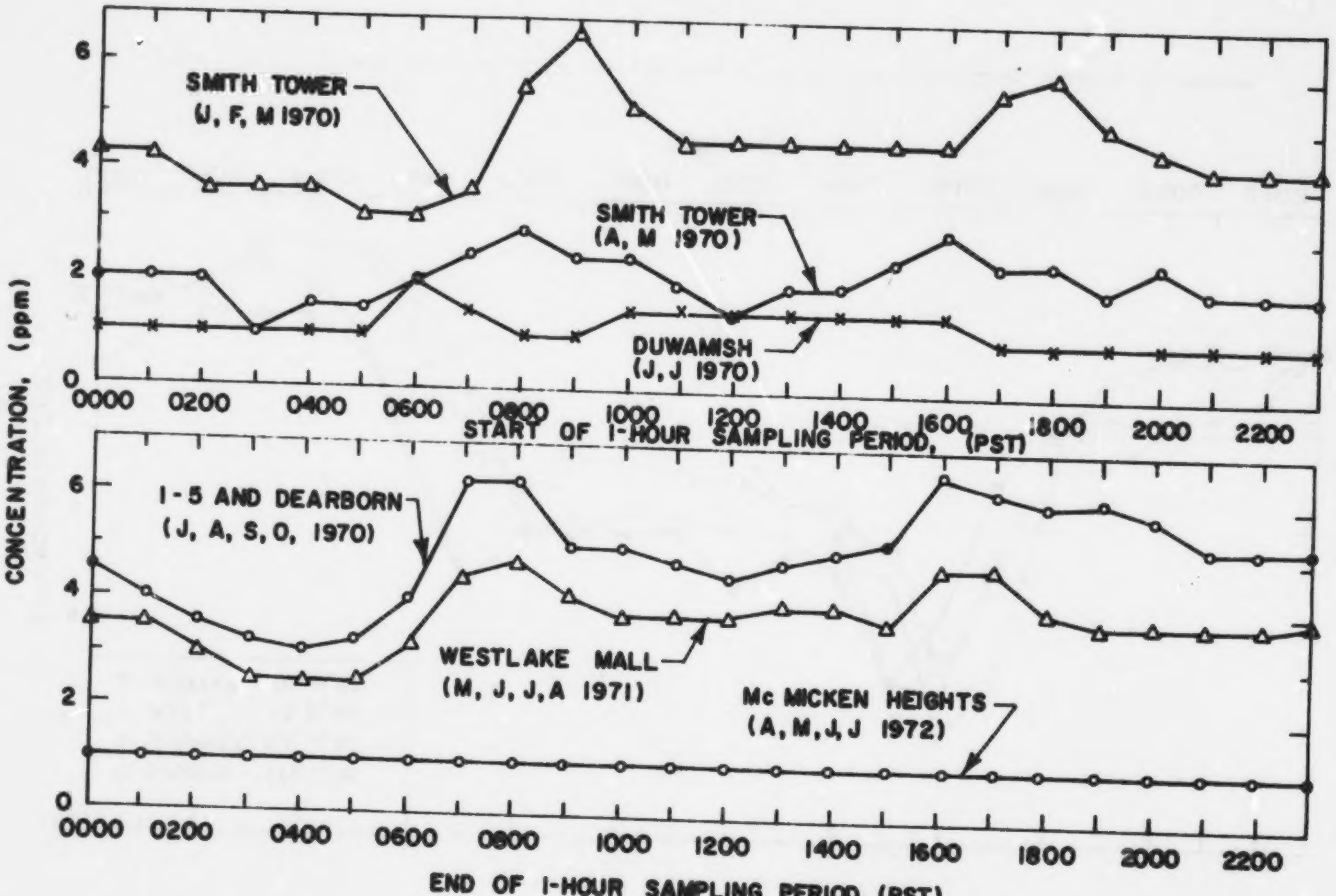

Figure II-4. Diurnal variation in CO concentration at 5 locations in Seattle.

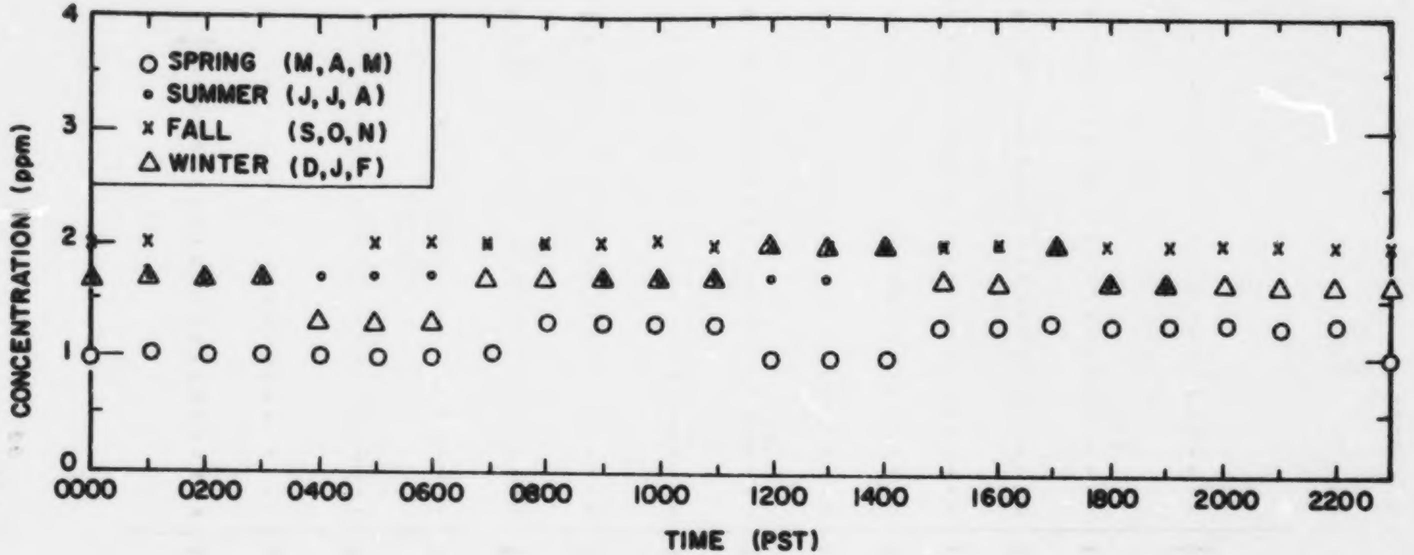

Figure II-5. Diurnal variation of CO concentration at Food Circus, Seattle, by season.

TABLE II-4

MAXIMUM 1-HOUR CO CONCENTRATIONS (IN PPM) OBSERVED AT [illegible], SEATTLE

HOUR	1971 JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1972 JAN	FEB	MAR	APR	MAY	MAXIMUM
00	4	4	3	3	6	5	3	3	5	4	3	2	6
01	4	3	3	3	6	4	6	3	5	4	3	2	6
02	4	3	3	3	6	4	6	3	5	3	3	2	6
03	4	3	3	4	6	4	6	3	5	3	3	2	6
04	4	3	3	3	5	4	7	2	5	3	2	2	7
05	4	3	3	3	5	3	7	2	5	2	2	2	7
06	4	3	3	4	5	3	6	3	5	3	2	2	6
07	4	3	4	5	5	3	5	4	4	3	2	2	5
08	3	3	5	5	6	3	5	4	5	3	3	3	5
09	4	3	5	5	6	3	6	4	5	3	2	2	5
10	3	2	3	4	6	3	6	3	5	3	3	4	6
11	4	3	3	4	6	3	6	3	5	3	2	3	6
12	4	3	3	4	6	3	7	4	6	3	2	2	7
13	4	3	3	3	6	3	6	4	6	3	2	2	6
14	3	3	3	3	6	3	5	4	4	3	3	2	5
15	4	3	3	3	6	4	6	3	5	3	3	2	5
16	4	4	3	4	6	4	6	3	5	4	4	2	5
17	4	3	4	2	6	5	5	4	5	4	4	2	6
18	4	3	3	3	7	5	4	4	6	5	3	3	6
19	4	3	3	3	5	5	4	3	6	5	2	2	6
20	4	3	4	4	6	5	3	3	5	5	2	2	6
21	4	4	4	6	6	5	3	3	6	6	3	2	8
22	4	4	4	7	8	5	3	3	7	5	3	2	8
23	4	5	6	5	7	5	3	3	6	5	3	2	7
MAXIMUM	5	5	5	7	8	5	7	5	7	6	4	4	8
% OBS.	92		96	95	97	97	93	97	92	74	81	91	

TABLE II-5

MAXIMUM 1-HOUR CO CONCENTRATIONS (IN PPM) OBSERVED AT SMITH TOWER AND DUWAMISH (5th AND MICHIGAN) SEATTLE

	Smith Tower 1970						Duwamish 1972		
Hour	JAN	FEB	MAR	APR	MAY	MAXIMUM	JUNE	JULY	MAXIMUM
00	10	9	6	5	3	10	4	3	4
01	8	7	6	5	3	8	3	3	3
02	8	10	6	3	3	10	3	2	3
03	7	10	5	3	2	10	3	1	3
04	8	10	5	3	3	10	3	2	3
05	4	9	5	3	5	9	3	3	3
06	5	9	5	3	8	9	4	4	4
07	6	11	6	3	6	11	4	3	4
08	9	17	8	7	6	17	3	3	3
09	18	17	12	7	5	18	3	3	3
10	10	13	10	4	6	13	3	3	3
11	12	10	8	3	4	12	3	2	3
12	11	8	8	4	4	11	3	2	3
13	10	7	7	4	4	10	3	2	3
14	8	7	8	5	4	8	4	3	4
15	10	8	8	6	5	10	4	4	4
16	9	8	8	7	8	9	3	4	4
17	12	9	11	7	5	12	3	2	3
18	13	17	11	6	4	17	3	3	3
19	12	10	9	5	3	12	3	2	3
20	10	9	8	4	5	10	3	3	3
21	7	8	6	4	7	8	4	3	4
22	10	9	8	7	7	10	4	4	4
23	8	12	8	6	5	12	4	4	4
MAXIMUM	18	17	12	7	8	18	4	4	4

TABLE II- 6

MAXIMUM 1-HOUR CO CONCENTRATIONS (IN PPM) OBSERVED AT THREE LOCATIONS IN SEATTLE

	I-5 AND DEARBORN 1970					WESTLAKE MALL 1971					[illegible] 1972				
HOUR	JULY	AUG	SEPT	OCT	MAXIMUM	MAY	JUNE	JULY	AUG	MAXIMUM	APR	MAY	JUNE	JULY	MAXIMUM
01	9	6	13	13	13	7	7	8	5	8	1	3	3	3	3
02	9	6	10	10	10	7	7	6	5	7	2	3	3	4	4
03	8	6	9	10	10	6	6	5	5	6	1	3	3	4	4
04	8	6	8	9	9	6	5	4	6	6	1	3	4	4	4
05	8	7	7	15	15	6	6	4	6	6	1	3	4	4	4
06	10	9	10	15	15	7	7	6	5	7	1	4	4	4	4
07	12	13	20	27	27	10	8	10	9	10	2	4	5	4	5
08	13	13	21	28	28	9	9	10	9	10	4	5	5	4	5
09	13	10	14	20	20	12	7	6	8	12	4	5	5	3	5
10	12	9	8	20	20	8	5	6	8	8	2	4	6	3	6
11	12	9	10	14	12	8	6	6	7	8	1	4	4	3	4
12	11	8	8	9	11	9	6	5	7	9	1	2	3	3	3
13	11	8	8	9	11	10	6	5	6	10	1	2	3	3	3
14	11	9	8	11	11	10	10	5	7	10	1	2	3	3	3
15	11	9	10	13	13	8	9	5	6	9	1	2	3	2	3
16	11	10	16	18	18	8	8	6	8	8	1	2	4	3	4
17	11	11	12	18	18	9	9	7	9	9	1	2	4	3	4
18	10	10	11	25	25	7	7	5	7	7	1	3	4	3	4
19	10	9	12	35	35	7	7	5	7	7	2	3	4	3	4
20	10	9	15	25	25	8	6	6	9	9	2	3	4	3	4
21	11	7	20	23	23	8	7	7	10	10	2	4	4	3	4
22	10	8	11	20	20	7	9	7	9	9	2	4	4	3	4
23	10	8	17	20	20	7	8	9	6	9	2	3	4	3	4
24	10	8	16	17	17	6	7	8	8	8	2	3	3	3	3
MAXIMUM	13	13	21	35	35	12	10	10	10	12	4	5	6	5	6
OBS.	82	96	90	88		45	85	98	99		21	91	95	86	

TABLE II-7

MAXIMUM 1-HOUR CO CONCENTRATIONS (IN PPM) OBSERVED AT THE MUNICIPAL BUILDING, SEATTLE.
AN ASTERISK INDICATES A VALUE GREATER THAN THE STANDARD (35 PPM)

HOUR	1971 AUG	SEPT	OCT	NOV	DEC	1972 JAN	FEB	MAR	APR	MAY	JUNE	JULY	MAXIMUM
00	6	7	7	8	11	5	8	7	8	4	4	7	11
01	6	7	6	4	8	4	7	5	6	3	4	6	8
02	5	7	5	3	7	6	7	5	7	3	3	4	7
03	4	7	5	3	5	4	4	4	6	3	3	3	7
04	5	5	4	3	4	4	6	3	3	3	2	4	5
05	6	7	6	3	3	4	6	3	3	6	5	7	7
06	13	17	16	8	6	5	6	5	5	12	12	16	17
07	18	19	10	16	16	15	18	18	4	10	16	17	19
08	14	17	14	18	25	23	20	25	10	13	14	16	25
09	14	16	13	15	23	15	15	13	16	13	13	18	23
10	13	13	13	13	18	8	14	16	16	11	14	15	18
11	12	15	14	13	13	10	13	14	13	12	13	13	15
12	18	13	17	9	13	14	18	17	11	13	16	15	18
13	13	13	17	13	18	16	20	21	14	12	13	12	21
14	13	14	16	19	16	15	19	18	12	13	13	14	19
15	18	25	27	19	18	19	22	22	13	19	18	18	27
16	20	30	20	30	27	29	29	31	24	16	16	20	31
17	18	17	12	23	23	25	38*	30	20	9	8	17	38*
18	10	12	14	12	13	11	18	14	9	6	6	8	18
19	12	10	13	10	8	8	17	16	8	5	6	6	17
20	10	10	13	7	7	8	14	13	5	6	6	8	14
21	13	8	10	7	6	7	15	13	5	6	7	8	15
22	12	9	9	7	12	4	14	10	7	7	8	8	14
23	8	8	8	6	13	5	9	7	12	4	6	8	13
MAXIMUM	20	30	27	30	27	29	38*	31	24	19	18	20	38
% OBS.	95	98	95	90	79	93	92	96	97	91	97	93	

This summary data is given for the last one-year period only for the Food Circus site.

Table II-8 gives the highest 8-hour concentration observed each month at each site. Of the recent measurements, only the 8-hour concentrations at the Municipal Building exceed the standard. Table II-8 also gives the number of times the 8-hour standard was exceeded each month. However, these values are based on a running mean of 8 one-hour averages. They do not, therefore, represent independent 8-hour periods.

Table II-9 lists the highest and second highest 1-hour and 8-hour average concentrations observed in Seattle between January 1970 and July 1972. The percent reductions in emissions required to meet the national standards at the two sites where the high readings occurred are also given in the table.

c. Oxidant Air Quality Data

Table II-10 gives the highest 1-hour concentrations of total oxidants at each site during each month of the sampling period. The national standard was exceeded 85 times at the I-5 and Dearborn site. Since October, 1970, the standard has been exceeded only nine times: three times at Food Circus in August 1971, and six times at Duwamish in July 1972.

The diurnal variations of total oxidant concentration at five of the six sites where oxidants were measured are shown in Figure II-6. The diurnal variation at the sixth site, Food Circus, is shown

TABLE II-8

SUMMARY OF MAXIMUM 8-HOUR CO CONCENTRATIONS (IN PPM) AT 7 LOCATIONS IN SEATTLE. NUMBERS IN PARENTHESES ARE NUMBER OF OBSERVATIONS GREATER THAN STANDARD (9 ppm)

Year	Month	Food Circus	Smith Tower	1-5 and Dearborn	Westlake Mall	McMicken Heights	Municipal Bldg.	Duwamish (5th & Mich.)
1970	Jan	7	9					
	Feb	12(81)	10(8)					
	Mar	10(110)	9					
	Apr	6	6					
	May	5	4					
	June	7						
	July	5		11(14)				
	Aug	6		10(4)				
	Sept	6		14(40)				
	Oct	7		21(90)				
	Nov	8						
	Dec	6						
1971	Jan	6						
	Feb	7						
	Mar	5						
	Apr	6						
	May	8			8			
	June	4			8			
	July	4			6		13(94)	
	Aug	4			8		15(70)	
	Sept	4					18(94)	
	Oct	6					16(115)	
	Nov	4					19(69)	
	Dec	6					17(59)	
1972	Jan	4					14(55)	
	Feb	5					20(86)	
	Mar	5					21(66)	
	Apr	3				2	14(19)	
	May	3				4	17(65)	
	June					4	14(68)	4
	July					4	14(60)	3

TABLE II-9

SUMMARY DATA FOR ESTIMATING REQUIRED REDUCTIONS IN CO EMISSIONS

Station	Sampling Period	Averaging Time	Concentration (ppm)			Reduction Required Percent Based on	
			Highest	2nd Highest	National Standard**	Highest	2nd Highest
I-5 & Dearborn*	July 1970- Oct. 1970	1-hour	35	28	35	0	0
		8-hour	21	20	9	57	55
Municipal Building	July 1971- July 1972	1-hour	38	31	35	8	0
		8-hour	21	20	9	57	55

* Used in Implementation Plan.

** Not to be exceeded more than once per year.

TABLE II-10

SUMMARY OF MAXIMUM 1-HOUR CONCENTRATIONS OF TOTAL OXIDANTS (IN PPM) AT 6 LOCATIONS IN SEATTLE. NUMBERS IN PARENTHESES ARE NUMBER OF OBSERVATIONS GREATER THAN STANDARD (0.08 ppm)

		Location					
Year	Month	Food Circus	Smith Tower	1-5 and Dearborn	Westlake Mall	McMicken Heights	Duwamish (5th & Mich.)
1970	Jan	.04	.07				
	Feb	.06	.08				
	Mar	.05	.05				
	Apr	.04	.04				
	May	.04	.06				
	June	.05					
	July	.06		.06			
	Aug	.06		.11(6)			
	Sept	.04		.16(39)			
	Oct	.06		.20(40)			
	Nov	.04					
	Dec	.04					
1971	Jan	.02					
	Feb	.02					
	Mar	.02					
	Apr	.02					
	May	.02			.02		
	June	.02			.02		
	July	.03			.05		
	Aug	.11(3)			.03		
	Sept	.03					
	Oct	.02					
	Nov	.01					
	Dec	.02					
1972	Jan	.07					
	Feb	.01					
	Mar	.02					
	Apr	.02				.03	
	May	.02				.07	
	June					.07	.04
	July					.07	.13(6)

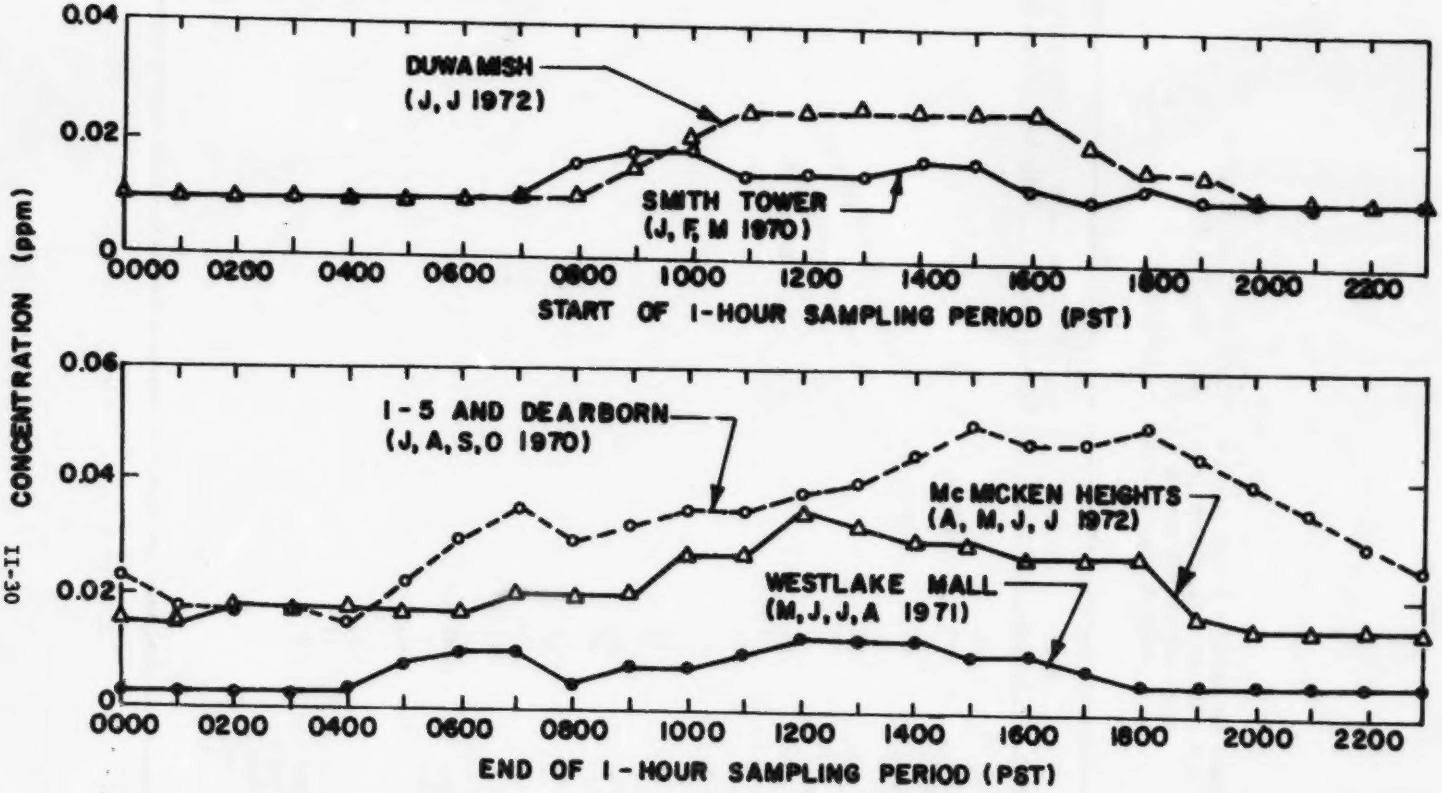

Figure II-6. Diurnal variation in total oxidant concentration at 5 locations in Seattle.

in Figure II-7. Again, hourly averages are entered in accord with the procedures of the collecting agency in these figures and in Tables II-11 through II-13 (see footnote, p. II-18). In a general sense, the five curves of Figure II-6 reflect the increase in oxidant levels expected as a result of photochemical reactions during the daytime period. However, the curve at I-5 and Dearborn shows a rapid increase in concentration starting between 0500 and 0600 PST, considerably earlier than would be expected as a result of photochemical reactions. The average concentration at this site continued to increase throughout the day reaching its peak in the early evening. Figure II-7 is a plot of the diurnal variation of oxidant concentration at Food Circus by season. Oxidant levels are generally quite low at all times of the day. Maximum values occur during the middle of the day in summer as expected. The average summertime daytime values measured at Food Circus are in close agreement with the average summertime values measured at Westlake Mall.

Tables II-11, II-12, and II-13 show the highest 1-hour concentration of the day for each month at each of the six sites. This detailed summary is given for the last one-year period only for the Food Circus site.

Table II-14 lists the highest and second highest 1-hour average oxidant concentrations observed in Seattle between January 1970 and July 1972. The percent reductions in hydrocarbon emissions required to meet the national standard (as indicated by Appendix J of 42 CFR, Part 420) at the three sites where the high readings occurred are also given in the table.

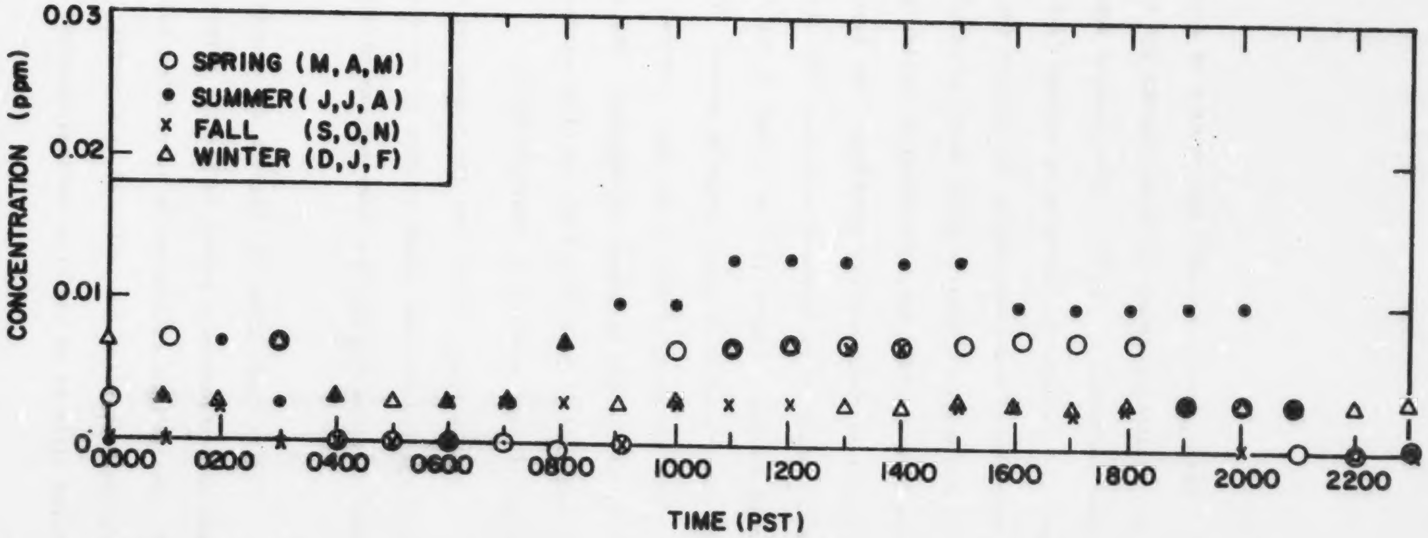

Figure II-7. Diurnal variation in total oxidant concentration at Food Circus by season.

TABLE II-11

MAXIMUM 1-HOUR CONCENTRATIONS OF TOTAL OXIDANTS (IN PPM) AT FOOD CIRCUS, SEATTLE.
AN ASTERISK INDICATES A VALUE GREATER THAN STANDARD (0.08 PPM).

HOUR	1971 JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1972 JAN	FEB	MAR	APR	MAY	MAXIMUM
00	.01	.01	.02	.01	.01	.01	.01	.02	.01	.01	.01	.01	.02
01	.01	.01	.02	.01	.01	.01	.01	.02	.01	.01	.01	.02	.02
02	.01	.01	.02	.01	.01	.01	.01	.02	.01	.01	.02	.02	.02
03	.01	.01	.02	.01	.01	.01	.02	.02	.01	.01	.02	.02	.02
04	.01	.01	.02	.01	.01	.01	.02	.02	.01	.01	.02	.01	.02
05	.01	.01	.02	.01	.01	.01	.02	.02	.01	.01	.02	.01	.02
06	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.02	.01	.02
07	.01	.01	.02	.01	.01	.01	.02	.01	.01	.01	.01	.01	.02
08	.01	.01	.02	.01	.01	.01	.02	.01	.01	.01	.01	.01	.02
09	.01	.01	.03	.01	.01	.01	.01	.07	.00	.01	.01	.01	.07
10	.01	.02	.04	.01	.01	.01	.02	.01	.01	.01	.01	.01	.04
11	.02	.03	.06	.03	.01	.01	.01	.01	.01	.01	.01	.01	.06
12	.01	.02	.10*	.01	.01	.01	.01	.01	.01	.01	.01	.02	.10*
13	.01	.02	.11*	.01	.01	.01	.01	.01	.01	.01	.01	.02	.11*
14	.02	.02	.09*	.01	.01	.01	.01	.01	.01	.01	.01	.02	.09*
15	.02	.02	.07	.01	.01	.01	.01	.01	.01	.01	.01	.02	.07
16	.02	.01	.06	.01	.01	.01	.01	.01	.01	.01	.01	.02	.06
17	.01	.02	.05	.01	.01	.01	.01	.01	.01	.02	[illegible]	.02	.05
18	.02	.02	.05	.01	.02	.01	.01	.01	.01	.01	.01	.02	.05
19	.01	.01	.05	.01	.02	.01	.01	.01	.01	.01	.01	.02	.05
20	.01	.01	.06	.01	.02	.01	.01	.01	.01	.01	.01	.02	.06
21	.01	.01	.04	.01	.02	.01	.01	.01	.01	.01	.01	.02	.04
22	.01	.01	.02	.01	.02	.01	.01	.01	.01	.01	.01	.01	.02
23	.01	.01	.02	.01	.01	.01	.01	.02	.01	.01	.01	.01	.02
MAXIMUM	.02	.03	.11*	.03	.02	.01	.02	.07	.01	.02	.02	.02	.11*
% OBS.	95		91	84	95	96	98	97	72	96	81	96	

TABLE II- 12

MAXIMUM 1-HOUR CONCENTRATIONS OF TOTAL OXIDANTS (IN PPM) OBSERVED AT SMITH TOWER AND DUWAMISH (5th AND MICHIGAN), SEATTLE
AN ASTERISK INDICATES A VALUE GREATER THAN STANDARD (0.08 PPM).

	Smith Tower 1970						Duwamish 1972		
Hour	JAN	FEB	MAR	APR	MAY	MAXIMUM	JUNE	JULY	MAXIMUM
00	.04	.04	.03	.03	.04	.04	.03	.02	.03
01	.04	.03	.03	.03	.04	.04	.03	.02	.03
02	.03	.04	.03	.03	.04	.04	.03	.02	.03
03	.03	.04	.03	.03	.04	.04	.03	.02	.03
04	.03	.04	.03	.04	.04	.04	.03	.02	.03
05	.03	.04	.03	.04	.04	.04	.03	.03	.03
06	.02	.05	.03	.03	.04	.05	.03	.03	.03
07	.04	.06	.03	.02	.04	.06	.03	.03	.03
08	.06	.08	.04	.02	.07	.08	.03	.04	.04
09	.07	.08	.05	.02	.04	.08	.03	.06	.06
10	.04	.05	.04	.03	.05	.05	.03	.08	.08
11	.04	.03	.03	.03	.05	.05	.03	.10*	.10*
12	.04	.03	.03	.03	.05	.05	.03	.08	.08
13	.04	.02	.03	.03	.06	.06	.04	.09*	.09*
14	.02	.02	.03	.04	.05	.05	.03	.10*	.10*
15	.03	.02	.03	.04	.06	.06	.03	.10*	.10*
16	.03	.02	.04	.04	.06	.06	.03	.13*	.13*
17	.04	.03	.04	.03	.04	.04	.03	.10*	.10*
18	.05	.04	.03	.03	.03	.05	.03	.08	.08
19	.06	.03	.04	.03	.03	.06	.02	.06	.06
20	.04	.03	.04	.02	.04	.04	.02	.06	.06
21	.04	.03	.04	.03	.04	.04	.02	.04	.04
22	.04	.03	.04	.03	.03	.04	.02	.03	.03
23	.03	.05	.03	.02	.04	.05	.02	.03	.03
MAXIMUM	.07	.08	.05	.04	.06	.08	.04	.13*	.13*

TABLE II-13

MAXIMUM 1-HOUR CONCENTRATIONS OF TOTAL OXIDANTS (IN PPM) OBSERVED AT THREE LOCATIONS IN SEATTLE.
NUMBERS IN PARENTHESES ARE NUMBER OF OBSERVATIONS GREATER THAN STANDARD (0.08 PPM).

	I-5 AND DEARBORN 1970					WESTLAKE MALL 1971					McMICKEN HEIGHTS 1972				
HOUR	JULY	AUG	SEPT	OCT	MAXIMUM	MAY	JUNE	JULY	AUG	MAXIMUM	APR	MAY	JUNE	JULY	MAXIMUM
01	.02	.06	.09(1)	.06	.09	.01	.01	.02	.02	.02	.01	.06	.03	.03	.06
02	.02	.04	.07	.05	.07	.01	.02	.01	.01	.02	.02	.06	.03	.02	.06
03	.02	.04	.05	.04	.05	.01	.02	.01	.01	.02	.02	.06	.03	.02	.06
04	.02	.03	.05	.03	.05	.01	.02	.02	.01	.02	.02	.04	.03	.02	.04
05	.02	.03	.04	.04	.04	.01	.01	.01	.01	.01	.03	.04	.03	.02	.04
06	.03	.04	.06	.05	.06	.01	.01	.01	.02	.02	.03	.04	.03	.02	.04
07	.06	.07	.08	.10	.10	.02	.01	.03	.03	.03	.03	.04	.04	.03	.04
08	.06	.09(1)	.07	.08	.09	.02	.01	.03	.02	.03	.03	.05	.04	.03	.05
09	.04	.09(1)	.08	.07	.09	.01	.01	.02	.02	.02	.03	.05	.04	.03	.05
10	.04	.06	.14	.07	.14	.01	.01	.02	.02	.02	.02	.05	.05	.04	.05
11	.03	.07	.15(1)	.07	.15	.01	.01	.02	.02	.02	.03	.05	.04	.05	.05
12	.03	.07	.16(2)	.06	.16	.01	.02	.03	.02	.03	.03	.07	.05	.05	.07
13	.03	.07	.09(1)	.07	.09	.01	.01	.04	.02	.04	.03	.04	.06	.06	.06
14	.03	.07	.08	.07	.08	.01	.02	.05	.03	.05	.03	.04	.07	.06	.07
15	.03	.07	.10(3)	.09(2)	.10	.01	.01	.05	.03	.05	.03	.05	.07	.07	.07
16	.04	.09(1)	.13(7)	.12(6)	.13	.01	.02	.03	.03	.03	.03	.05	.05	.07	.07
17	.03	.09(2)	.10(2)	.13(6)	.13	.01	.02	.03	.03	.03	.03	.05	.05	.07	.07
18	.03	.11(1)	.11(3)	.19(8)	.19	.01	.02	.03	.02	.03	.03	.05	.04	.06	.06
19	.03	.09(2)	.12(6)	.20(6)	.20	.01	.02	.03	.02	.03	.03	.04	.03	.05	.05
20	.03	.10(2)	.11(6)	.15(6)	.15	.01	.01	.02	.02	.02	.02	.04	.03	.05	.05
21	.04	.08	.15(2)	.13(6)	.15	.01	.01	.02	.02	.02	.02	.04	.03	.03	.04
22	.03	.08	.10(2)	.10(6)	.10	.01	.01	.02	.02	.02	.02	.04	.03	.03	.04
23	.03	.07	.13(2)	.10(3)	.13	.01	.01	.02	.02	.02	.02	.04	.03	.03	.04
24	.02	.07	.10(2)	.08	.10	.01	.01	.02	.02	.02	.02	.04	.04	.03	.04
MAXIMUM	.06	.11	.16	.20	.20	.02	.02	.05	.03	.05	.03	.07	.07	.07	.07
OBS.	63	58	79	91		51	99	82	93		28	50	66	72	

TABLE II-14

SUMMARY DATA FOR ESTIMATING REQUIRED REDUCTIONS IN HYDROCARBONS EMISSIONS

Station	Sampling Period	Averaging Time	Oxidant Concentration (ppm) Highest	Oxidant Concentration (ppm) 2nd Highest	Oxidant Concentration (ppm) National Standard**	Reductions in Hydrocarbons Required (Percent) Based on Highest	Reductions in Hydrocarbons Required (Percent) Based on 2nd Highest
I-5 and Dearborn*	July 1970- Oct 1970	1-hour	0.16	0.15	0.08	53	48
Food Circus	Jan 1970- May 1972	1-hour	0.11	0.10	0.08	26	18
Duwamish	June 1972- July 1972	1-hour	0.13	0.10	0.08	38	18

[*] Used in Implementation Plan. Only values measured between 0900 and 1600 PST were considered.

[**] Not to be exceeded more than once per year.

4. Impact of Stationary Sources

a. Major CO Sources

The major point-sources (emission rate greater than 50 tons per year) of CO in King County, arranged in descending order of emission rate, are listed in Table II-15. Except for aircraft operations, the largest source is the Olympic Foundry which emits 455 tons per year or 13 grams per second. This foundry is located approximately three miles south of the CBD. The use of any conventional point source diffusion model (see, for example, Turner's Workbook of Atmospheric Dispersion Estimates) will show that the maximum ground level concentration expected from a source of this magnitude is a small fraction of the allowable concentration even under unfavorable meteorological conditions. As an example, a low-level source of 13 grams per second under class E stability conditions and a wind speed of 2 meters per second yields a peak ground level concentration (10-min average) 1 kilometer from the source of about 1.8 milligrams per cubic meter, or about five percent of the one-hour standard. Accordingly, as a sufficiently accurate approximation for the proportional modeling carried out in Section IID, CO emissions other than those from vehicular traffic are considered uniform throughout the critical area.

b. Major Hydrocarbon Sources

Table II-16 lists the major points sources of hydrocarbons in King County in descending order of emission rate. For the proportional modeling carried out in Section IID, hydrocarbon emissions from non-vehicular sources are considered uniform throughout the critical area.

TABLE II- 15

MAJOR POINT SOURCES OF CO EMISSIONS - KING COUNTY (1970)

COMPANY	SOURCE CATEGORY	EMISSIONS (TON/YEAR)
Seattle-Tacoma International Airport	Aircraft	2830
Boeing Field	Aircraft	1205
Renton Municipal Airport	Aircraft	517
Olympic Foundry	Process Losses	455
Weyerhaeuser Co. (Snow Falls)	Hogged Fuel	192
Bellevue Airfield	Aircraft	163
Weyerhaeuser Co. (White River)	Hogged Fuel	128
Auburn Field	Aircraft	109
Pacific Car and Foundry	Process Losses	96
Kenmore Air Harbor	Aircraft	79
Lake Union Air Service	Aircraft	63

TABLE II-16

MAJOR POINT SOURCES OF HYDROCARBONS EMISSIONS-KING COUNTY (1970)

COMPANY	SOURCE CATEGORY	EMISSIONS (TONS/YEAR)
Seattle-Tacoma International Airport	Aircraft	2928
American Can	Fuel	27
	Process Losses	592
Pacific Car and Foundry	Fuel	5
	Process Losses	442
Weyerhaeuser Co. (Snow Falls)	Hogged Fuel	192
	Process Losses	2
Todd Shipyards	Fuel	3
	Process Losses	145
Weyerhauser Co. (White River)	Hogged Fuel	128
Boeing (Auburn)	Fuel	17
	Process Losses	105
Lockheed Shipbuilding	Fuel	2
	Process Losses	105
Boeing Field	Aircraft	100
Boeing/Plant II	Fuel	22
	Process Losses	57
Boeing/Renton	Fuel	23
	Process Losses	41
U. S. Plywood Corp.	Hogged Fuel	44
	Process Losses	19
Ideal Cement Co.	Fuel	52

C. DISCUSSION OF 1971 AND 1977 VEHICLE MILES OF TRAVEL

1. General

This section provides information on vehicle miles of travel (VMT) within high traffic density areas of the Puget Sound Intrastate Area for the calculation of vehicle emissions and subsequent evaluation of air quality. The travel data is one of the bases for developing transportation control strategies that will achieve air quality standards for carbon monoxide and oxidants by 1977. The steps in the procedure include selection of critical areas by inspection of traffic counts, calculation of vehicle miles of travel for 1971, and projection of vehicle miles of travel to 1977 based on recent growth trends.

The higher traffic densities in the Puget Sound Area are found in Seattle and vicinity (King County), Tacoma (Pierce County), and Everett (Snohomish County).

2. Methodology

a. Development of Grid Network

Vehicle mile data for the Puget Sound region were developed by the Washington State Highway Department and the Puget Sound Governmental Conference. These data, however, were either for the region as a whole or were for specific facilities within the region. Therefore, methodology had to be developed to provide data on vehicle miles of travel for small areas within the region where air pollution emissions were high and air quality was poor.

One-square-mile grids were developed (along range and township lines for possible coordination with the Puget Sound Governmental Conference) on USGS maps at a scale of 1:24,000. Using a twenty-four hour average daily traffic (ADT) flow map produced in 1969 for the Puget Sound Region by the Puget Sound Governmental Conference, areas of greatest traffic concentration were selected for coverage with these mile-square grids. Initially, 19 square-mile grids were analyzed in the Seattle, Tacoma and Bellevue area.

To ensure that calculations of vehicle miles of travel were available for all potential "hot spots" of poor air quality, a rough estimate of a critical VMT level was made by examining air quality data and associated VMT's. The grid network was increased until grids with estimated high emission levels were surrounded by grids with VMT's well below the critical level, initially estimated to be 130,000. To do this, the number of grids in the Seattle area were increased to 50, as shown in Figure II-8.

b. 1971 Vehicle Miles of Travel

The 1971 daily vehicle miles of travel were calculated for each square mile studied by measuring the length of each street or highway facility within each grid and multiplying its length times the ADT volume obtained from the most current traffic flow maps, plus data from the Annual Traffic Report Series produced by the Washington State Highway Commission. Traffic flow maps were obtained from the cities of Seattle, Bellevue, Renton, Everett, and Tacoma.

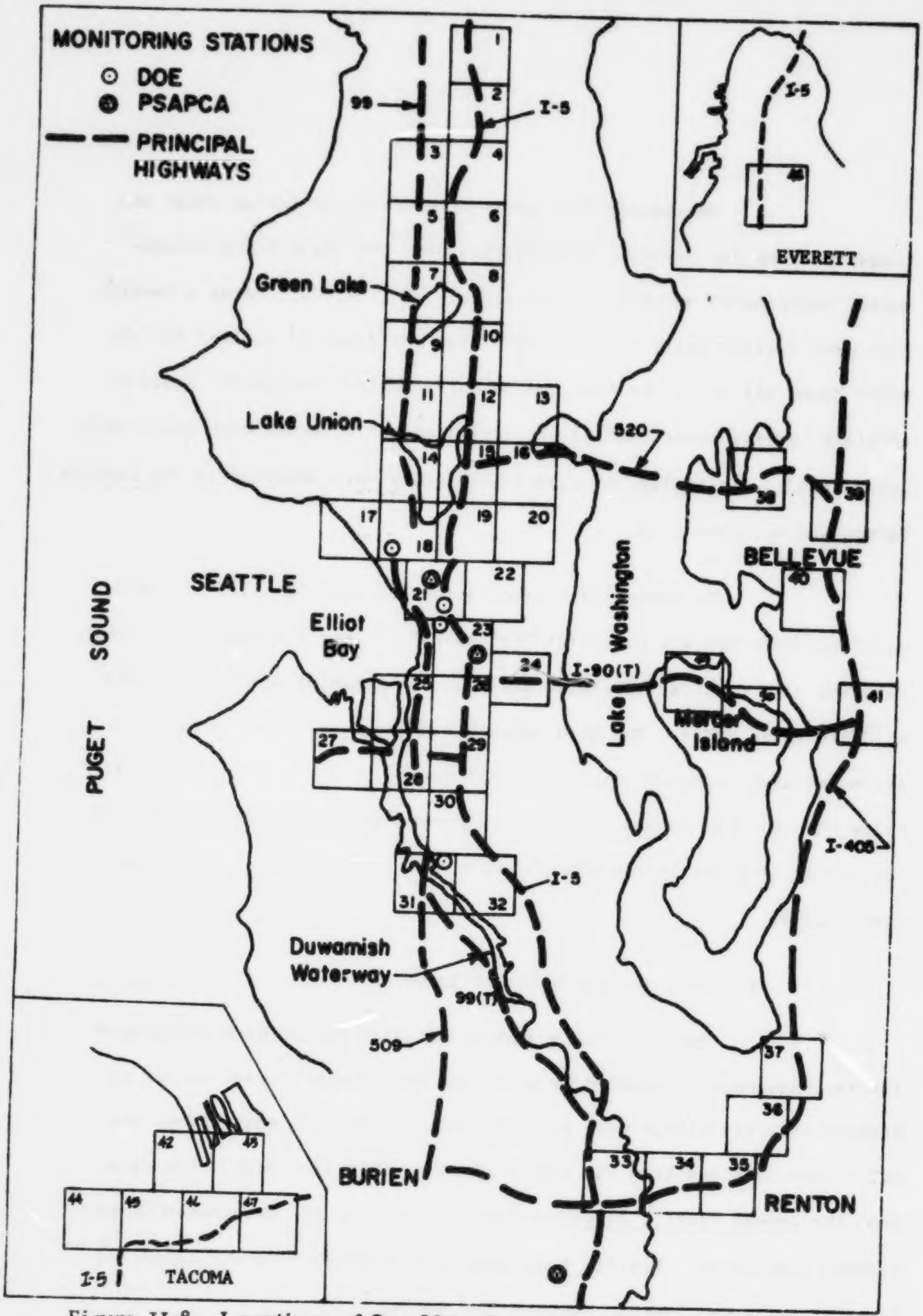
MONITORING STATIONS
⊙ DOE
● PSAPCA
PRINCIPAL HIGHWAYS
99
I-5
Green Lake
Lake Union
520
SEATTLE
Elliot Bay
PUGET SOUND
Lake Washington
I-90(T)
Mercer Island
BELLEVUE
I-405
Duwamish Waterway
99(T)
509
BURIEN
RENTON
TACOMA
EVERETT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50

Figure II-8: Locations of One-Mile-Square Grids - Seattle Area

This calculation was carried out separately for each roadway that was on a flow map and included in a grid. In cases where a length of roadway within a grid had substantially different traffic volumes in various locations, the roadway was split into two or more sections for the vehicle mile calculation.

Information for average network speed was obtained from TOPICS studies or from surveys of peak and off-peak roadway speeds which were made by the city traffic engineers. Table II-17 summarizes these data. Table II-17 was used as a guideline for selecting and assigning average speeds on each roadway in the absence of specific data for that facility.

Data were collected from screenline and arterial traffic counts so that the hourly traffic profile could be evaluated. Figure II-9 shows the profile used for Seattle, and Table II-18 lists the hourly percentages.

From the diurnal traffic profile data, the percentages of daily traffic that would occur in various critical time periods were developed. These time periods were:

(1) The peak hour (usually in the afternoon)
(2) 6:00 a.m. to 9:00 a.m. in the morning
(3) The highest 8 hours of the day.

The appropriate portion of the daily vehicle miles of travel occurring in each time period was calculated using these percentages, and the average

TABLE II-17 GUIDELINE AVERAGE SPEEDS (MPH)

Roadway Classification	CBD		CBD Fringe		Other Urban	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Freeway	40-45	45-50			50	55-60
Expressway					35	35
Arterial and Collector	18	18	20	20	20	25

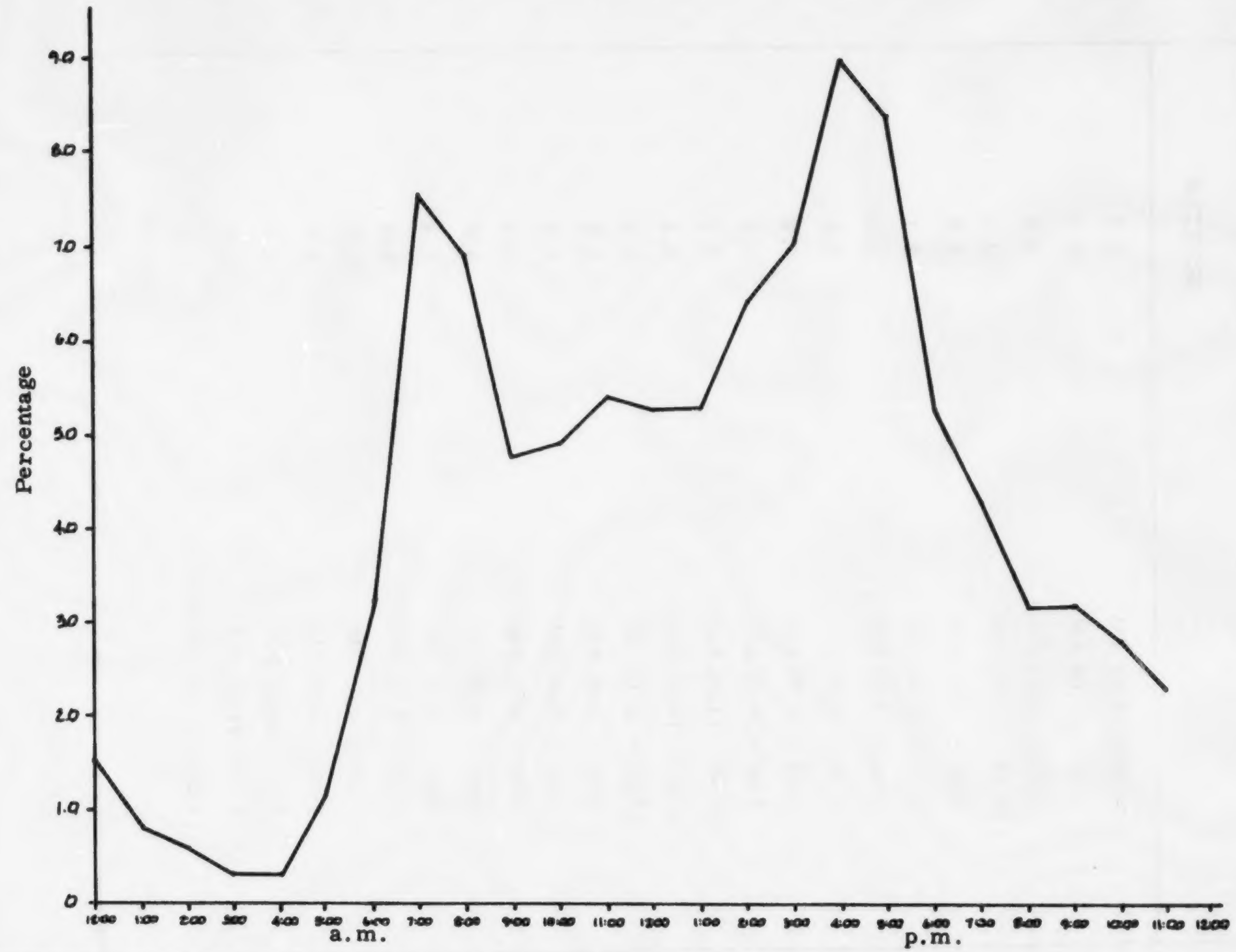

Figure II-9. Percent of Average Daily Traffic by Hour - Seattle Area

TABLE II-18 PERCENT OF DAILY TRAFFIC BY HOUR

	SEATTLE
12:00 - 1:00 AM	1.5
1:00 - 2:00 AM	0.8
2:00 - 3:00 AM	0.6
3:00 - 4:00 AM	0.3
4:00 - 5:00 AM	0.3
5:00 - 6:00 AM	1.1
6:00 - 7:00 AM	3.2
7:00 - 8:00 AM	7.6
8:00 - 9:00 AM	6.9
9:00 - 10:00 AM	4.8
10:00 - 11:00 AM	4.9
11:00 - 12:00 Noon	5.4
12:00 - 1:00 PM	5.3
1:00 - 2:00 PM	5.3
2:00 - 3:00 PM	6.4
3:00 - 4:00 PM	7.1
4:00 - 5:00 PM	9.0
5:00 - 6:00 PM	8.4
6:00 - 7:00 PM	5.3
7:00 - 8:00 PM	4.3
8:00 - 9:00 PM	3.2
9:00 - 10:00 PM	3.2
10:00 - 11:00 PM	2.8
11:00 - 12:00 Midnight	2.3
	100.0%

speed for each facility was assigned for that particular time period. In the Puget Sound Region the peak hour was 9.0 percent, the morning three hours were 17.7 percent, the highest 8 hours 51.8 percent.

Streets that were not included on the traffic flow maps were assumed to be in the "local streets" category. Mileage for these streets was measured by grid. A speed of 15 miles per hour and an ADT of 500 vehicles per day was assumed for local streets. The vehicle miles of travel generated for local streets were added to that estimated for the freeways, arterials, and collector roadways appearing on traffic flow maps.

Table II-19 shows vehicle mix and classification data for the Puget Sound region. The 1971 registration data by vehicle type were obtained using the State registration data as a basic source. The daily vehicle trip information is from origin and destination surveys conducted by the transportation study groups in each area. The breakdown on daily vehicle miles of travel is from similar information, but has been sub-divided into the three vehicle types using information on the trip lengths for automobiles and commercial vehicles and for internal trips and through trips.

Vehicle age mix was obtained from two sources. Statewide data was obtained from the Washington Department of Motor Vehicles by the Department of Ecology. A breakdown by county was obtained from the R.L. Polk and Company. These data are summarized in Table II-20.

TABLE II-19

VEHICLE MIX AND CLASSIFICATION*

	Puget Sound Region			
	King**	Pierce***	Snohomish▽	Statewide
1971 Registration:				
Gasoline light duty	83.3%	80.6%	76.0%	79.1%
Gasoline heavy duty	16.2	19.2	22.7	20.5
Non-gasoline	0.5	0.2	1.3	0.4
	100.0%	100.0%	100.0%	100.0%
Study Year:		1961		
Daily Vehicle Trip:				
Auto		87.4%		
Truck		12.6%		
		100.0%		
Daily VMT:				
Gasoline, light duty		88.8%		
Gasoline, heavy duty		9.1		
Non-gasoline		2.1		
		100.0%		

*Not including motorcycles

**Seattle, Renton, Bellevue

***Tacoma

▽Everett

TABLE II-20

VEHICLE AGE MIX

Model Year	Statewide as of	King County 1972	Pierce County 1972
72	--	16,439	5,131
71	58,644	31,990	9,700
70	108,632	32,911	9,861
69	132,956	43,717	12,433
68	132,599	43,829	12,565
67	129,889	43,231	12,338
66	136,964	44,261	12,892
65	136,427	41,183	12,829
64	116,486	32,933	10,999
63	107,192	28,891	9,486
62 & prior	403,260	80,736	28,376
Total	1,463,049	440,121	136,610

Source: Washington Department of Motor Vehicles and
R. L. Polk & Co.

c. 1977 Vehicle Miles of Travel

For 1977 it is assumed that:

- The distribution of vehicle miles of travel by type of vehicle is the same as 1971.
- The diurnal traffic profile is the same as 1971.

The two techniques used in estimating 1977 vehicle miles of travel were (1) trend projections and (2) growth factors. Since the time period from 1971 to 1977 is relatively short term, a trend projection method was judged to be at least as accurate as using currently available travel forecasts based on model and traffic assignment techniques. Moreover, short-range future assignments of travel to current streets were not available.

For Seattle, trends of growth are confused by a downturn in volume from 1969 to 1971, undoubtedly caused by economic setbacks. It is now felt that growth will be more-or-less level for a few years, and then growth will accelerate to previous rates. Continuing studies by the State Department of Employment Security, Pacific Northwest Bell, and those reported in A Transit Plan for the Metropolitan Area - Seattle-King County, by Daniel, Mann, Johnson and Mendenhall in May 1972 indicate that King County growth would be at a ratio 1.17 from 1971 to 1977. This ratio was calculated by taking the product of growth of employment, growth in labor force, and growth of vehicles per person. With this as a guideline, volumes were estimated at little or no growth to 1975, and extrapolated at rates exhibited during the 1960's from 1975 to 1977. Each grid was analyzed separately for freeway and surface street.

Interstate 5 (I-5) presented problems related to speed, as did several other freeways and heavily traveled arterials. During certain periods of the day these facilities were at capacity in 1969. Although the volumes are below 1969 levels, these facilities are nearly at capacity today. Therefore, speed was reduced as volume increased on these facilities along lines indicated by speed-volume curves in the Highway Capacity Manual. (Highway Research Board, Highway Capacity Manual, Special Report No. 87, 1965). The little diversion away from the freeway to adjacent arterials was estimated under these conditions.

In developing the 1977 VMT's transportation system improvements currently under consideration were treated in the following manner:

(1) A project involving surveillance of traffic, geometric improvements, ramp metering, and driver information is proposed for Interstate 5 from the Seattle central business district to the North. The initial calculations of the 1977 vehicle miles of travel was done under the assumption that this project is not implemented. Therefore, this freeway traffic control project could become a candidate strategy for subsequent evaluation if an air quality problem is identified in the I-5 corridor.

(2) The METRO bus system has been approved by King County voters. This system (financed by a sales tax increase) will preserve bus service within the City of Seattle, expand local bus service into suburban areas, and create express bus service throughout the area using the freeways. The implementation of this system (starting in 1973) will

cause patronage to increase in 1977 24 percent in Seattle, and over 600 percent in the suburbs. The impact of this increase was accounted for with the following methodology.

- All available screenline data were plotted for auto users and bus passengers. This included screenlines along the north Seattle City Limits, the Ship Canal, the southerly Seattle City Limits, and the easterly Seattle City Limits at Lake Washington.
- The plan for the METRO bus system included forecasts of patronage by year from 1973 to 1980. These forecasts were used to scale back 1980 screenline transit forecasts to the 1977 period.
- The growth factor for auto travel (previously calculated using growth trends) was then reduced to reflect the impact of increased transit use. Data were available from the METRO Transit Plan to differentiate between growth of local service and passengers using the express service. These data indicate that little growth in transit patronage should be expected in the Seattle area where an extensive transit system already exists. However, for express service connecting to Seattle a substantial growth in patronage was forecasted. The actual adjustment to the auto growth factor was a reduction in that factor which was calculated by dividing the difference in bus passengers (1977 minus 1971) by vehicle occupancy and the 1971 vehicle volume.

> This modified growth factor is applied to the 1971 vehicle miles of travel selectively by grid zone.

(3) The King County Domed Stadium is scheduled to open in the fall of 1975 just south of downtown Seattle. This facility will have two impacts on travel. First, normal daily travel in the vicinity of the stadium will be dispersed over more streets than at the present through the construction of an arterial along the southern boundary of the stadium. This new east-west arterial will provide additional travel routes and thereby reduce volumes and improve speeds on other adjacent arterials. A manual re-assignment of volumes was made to reflect this system modification.

Traffic generated by the stadium itself will also impact on the adjacent street system. Weekday stadium events are expected to occur about 130 days a year. Planning studies for the stadium indicate an average weekday attendance of 10,000 persons utilizing 4,000 parking spaces, and maximum attendance of 13,000. This would generate about 11,000 trips and about 8,000 vehicle miles of travel. However, this travel will occur after 6:00 p.m. and is therefore outside of the maximum 8- hour period.

Saturday events would include some peak crowds, and average weekend attendance is estimated at 39,000 utilizing 8,300 parking spaces. Maximum attendance would be 62,000 using some 10,800 parking spaces. With an average trip length of .67 miles assumed within the grid, 14,000 vehicle miles of travel were estimated. This travel, when added to expected Saturday daily vehicle miles of travel in the grid zone, is less than weekday totals. The 8-hour total is also less than weekdays, and the peak hour is about the same.

Therefore, unless Saturday VMT grows excessively by 1977, it is assumed that an analysis of weekday travel under non-stadium conditions would provide a reasonable evaluation for the grid zone.

The total daily vehicle miles of travel resulting from the calculations and assumptions described above for grids in Seattle are shown in Figure II-10.

(4) The improvement of Interstate 90 from Bellevue into Seattle will create additional vehicle capacity to I-5 (at a higher level of service than at present) plus exclusive lanes for express bus transit. However, it is estimated that I-90 will not be fully open for traffic until 1980. Therefore, its impact in 1977 (and 1978 and 1979) is included, on the premise that facilities will exist only for express buses. No increase in average speeds is assumed and volume growth is forecasted along current trend lines.

D. DERIVATION OF 1977 AIR QUALITY LEVELS

1. General

The methodology presented in Section II-A, which assumes that ambient concentrations are directly proportional to the total emissions of the pollutant over an area of appropriate size, was used to

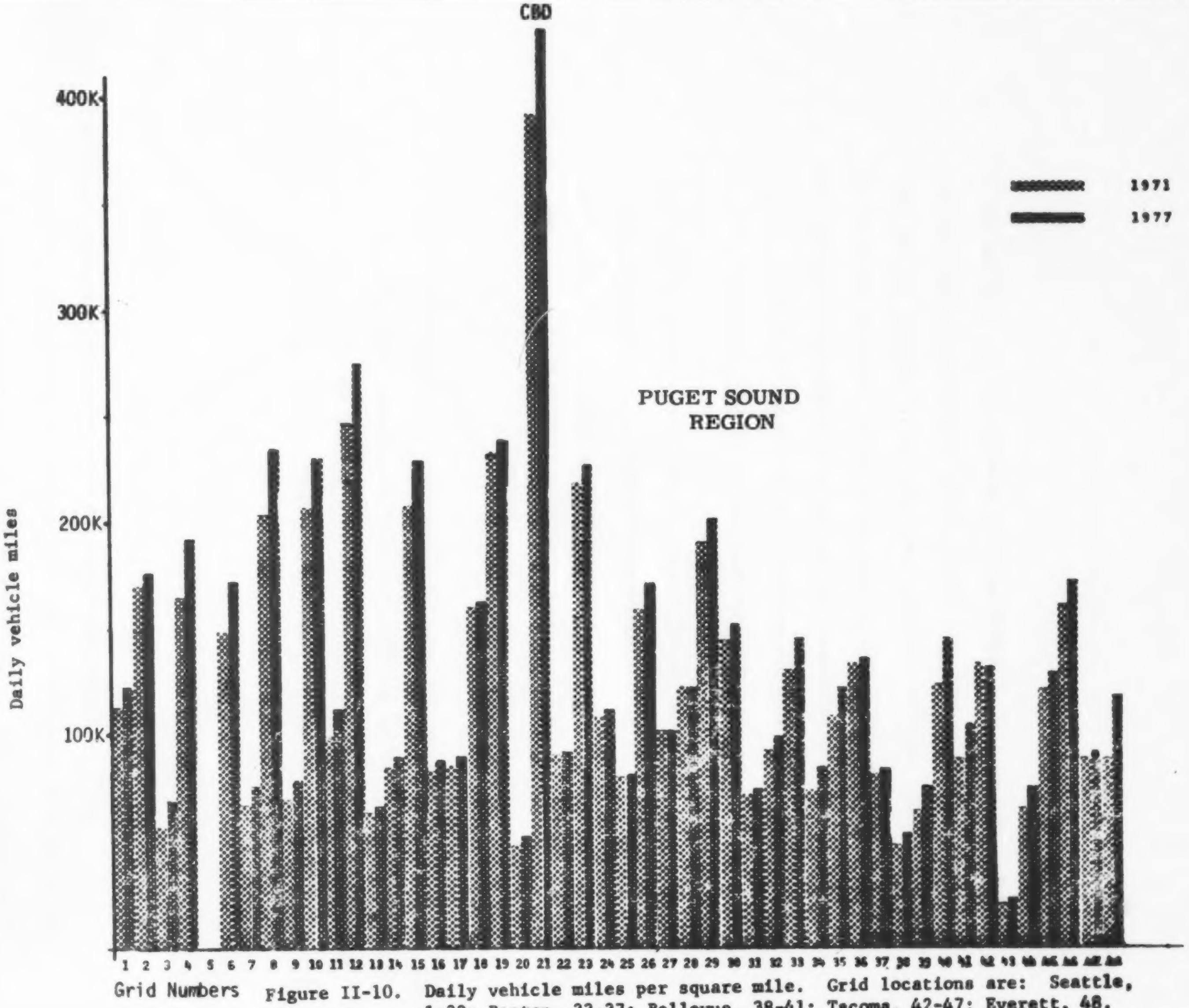

Figure II-10. Daily vehicle miles per square mile. Grid locations are: Seattle, 1-32; Renton, 33-37; Bellevue, 38-41; Tacoma, 42-47; Everett, 48.

Reproduced from best available copy.

estimate the maximum allowable emission density and the level of air quality expected in 1977 as a result of the Federal Motor Vehicle Control Program. The 1977 estimates were made using baseline VMT and air quality data for 1971. The percent reduction in vehicular emissions required by means of strategies was estimated by comparing calculated 1977 emission densities with the maximum allowable emission density. Allowance was made for non-vehicular emissions in the calculations.

The areas for which vehicle emissions were calculated were shown in Figure II-9. To ensure consideration of all areas with high emission rates, preliminary calculations were made for 18 square miles in Tacoma, Renton, Bellevue, Mercer Island, and Everett in addition to the principal area of 32 square miles in Seattle.

Hydrocarbon emission densities were calculated for the 3-hour period from 0600 to 0900 local time in agreement with the time period specified by the national standard for hydrocarbons. Carbon monoxide emission densities were calculated for the 8-hour period of maximum traffic.

2. Estimation of CO Levels

a. Emission Densities within Core Area

Vehicular Emissions - Emission densities were calculated for all 50 one-mile-square zones for 1971 and 1977 using the traffic data given in Appendix A, and the EPA emission factors discussed in Section II A.

Emission densities were also calculated for 1970 for Zones 1-41 by increasing the 1971 VMT's by 2.5 percent. Figure II-11 shows the results for all zones for 1971 and 1977. The computer printout listing the results for all three years by vehicle type is included in Appendix B.

Non-Vehicular Emissions - Table II-21, compiled from data presented in Appendix C of the Implementation Plan, shows that of the 742,956 tons of CO estimated to have been emitted within King County during 1970, only 29,397 tons, or 4 percent, are from non-vehicular sources. Also, more than half of this amount was from sources such as aircraft and solid waste disposal which are not likely to significantly affect concentrations within the CBD. Table II-22 gives the emission rates for various source categories for the Puget Sound Intrastate A.Q.C.R. in 1970 and 1975. For non-vehicular sources, these estimates show either no change or a decrease in emission rate between the two years. In the proportional modeling which follows, we attribute 2 percent of the CO emissions affecting the CBD to non-vehicular sources in 1970 and leave their emission rate unchanged throughout the 1970-1979 period.

Selection of Air Quality Baseline - As shown in Section II-B-3, the CO monitor that was located at I-5 and Dearborn for four months in 1970 yielded a second-highest, 8-hour average concentration of 20 ppm. However, as pointed out in the Implementation Plan, it is inappropriate to compare measurements made along a major freeway with the 8-hour standard

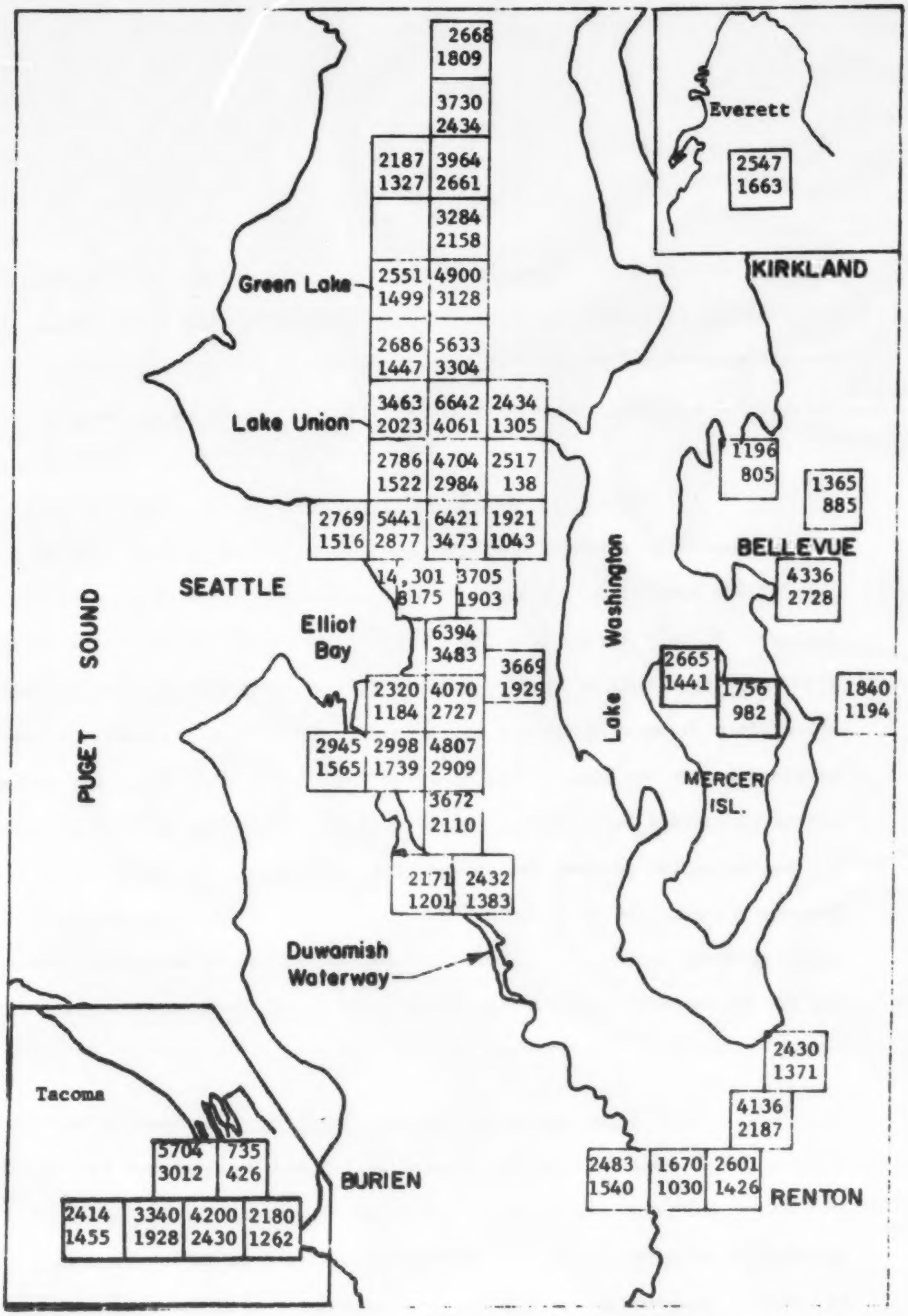
Everett
2547
1663
KIRKLAND
2668
1809
3730
2434
2187
1327
3964
2661
3284
2158
Green Lake
2551
1499
4900
3128
2686
1447
5633
3304
Lake Union
3463
2023
6642
4061
2434
1305
2786
1522
4704
2984
2517
138
1196
805
1365
885
2769
1516
5441
2877
6421
3473
1921
1043
BELLEVUE
SEATTLE
14,301
8175
3705
1903
4336
2728
PUGET SOUND
Elliot Bay
6394
3483
Lake Washington
3669
1929
2665
1441
1756
982
1840
1194
2320
1184
4070
2727
2945
1565
2998
1739
4807
2909
MERCER ISL.
3672
2110
2171
1201
2432
1383
Duwamish Waterway
2430
1371
Tacoma
4136
2187
5704
3012
735
426
BURIEN
2483
1540
1670
1030
2601
1426
RENTON
2414
1455
3340
1928
4200
2430
2180
1262

Figure II- 11. Maximum 8-Hour CO emission densities (KGM/Sq. Mi) in Seattle. Upper values are for 1971, lower values are 1977 emissions based on Federal Motor Vehicle Control Program.

TABLE II-21

CO EMISSION ESTIMATES FOR KING COUNTY IN 1970

SOURCE CATEGORY	EMISSIONS (TONS/YEAR)
Fuel Combustion	4,469
Process Losses	598*
Solid Waste Disposal	9,418*
Transportation	
Motor Vehicles	713,559
Aircraft	5,077*
Other	6,977
Miscellaneous Area	2,858*
Subtotal (Non-Vehicular)	29,397 (4 %)
Total	742,956

*From sources not likely to significantly affect the CBD.

TABLE II- 22

CO EMISSION ESTIMATES FOR PUGET SOUND INTRASTATE A.Q.C.R.

SOURCE CATEGORY	EMISSIONS (TONS/YEAR)	
	1970	1975
Process Losses	9,627	7,197
Fuel Combustion	8,363	8,363
Transportation*		
Motor Vehicles	1,095,438	809,438
Other	18,505	18,505
Solid Waste Disposal	23,782	14,052
Miscellaneous Area Sources	8,675	8,175
Subtotal (Non-Vehicular)	68,952	56,292
Total	1,164,390	865,730

*1970 values have been distributed in accord with breakdown given in King County 1970 estimates (Appendix C, Implementation Plan). "Other" transportation emissions are left unchanged for 1975.

unless the monitored area is occupied by people for a comparable period. This statement simply represents, in GCA's opinion, preferred monitoring practice. It is not meant to preclude the possibility that a local area of high concentrations existed (or exists) in the vicinity of I-5 and Dearborn. When concentrations were averaged over a one-hour period, which more closely corresponds to the period of exposure experienced by freeway drivers, the highest value equaled, but did not exceed, the one-hour standard of 35 ppm.

The second monitor that measured concentrations of possible concern was located at the City Municipal Building. This monitor is currently in operation at this location, and the site was visited by GCA personnel. The intake of the monitor extends outward from the face of the parking building over the edge of the sidewalk, and is at a height of about 15 feet above the ground. In our opinion, the instrument is not excessively influenced by vehicles entering and leaving the parking building, although the measured values include some contribution from those vehicles. The Municipal Building is located within the CBD in the one-mile-square zone (Zone 21) of maximum CO emissions.

A second site within the CBD, Westlake Mall, was monitored for four months in 1971. During this period, no 8-hour concentrations were measured which were in excess of the standards. In fact, during the two months when observations were made at both the Municipal Building and Westlake Mall, the maximum 8-hour concentrations at Westlake Mall were approximately one-half those at the Municipal Building. Figure II-12 shows the

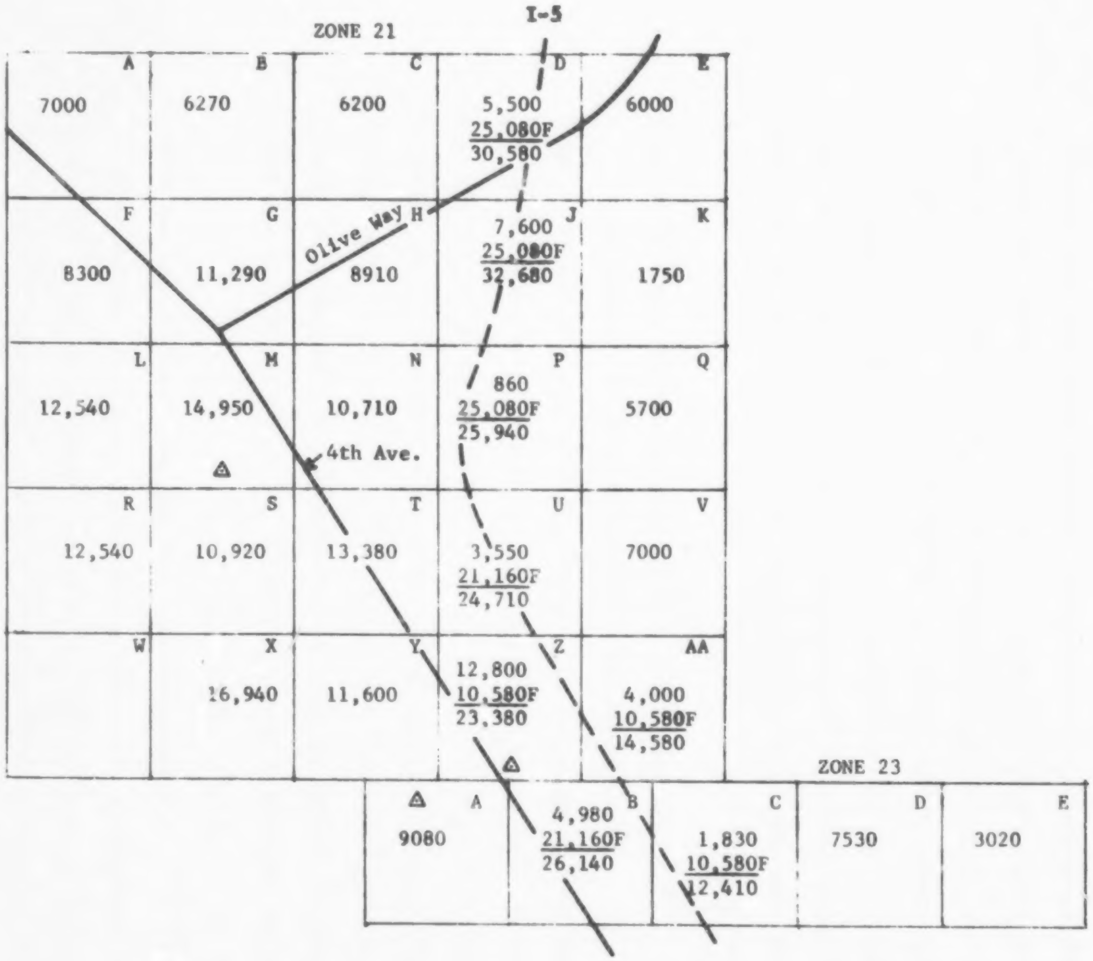
ZONE 21
I-5
A
7000
B
6270
C
6200
D
5,500
25,080F
30,580
E
6000
F
8300
G
11,290
Olive Way
H
8910
J
7,600
25,080F
32,680
K
1750
L
12,540
M
14,950
N
10,710
4th Ave.
P
860
25,080F
25,940
Q
5700
R
12,540
S
10,920
T
13,380
U
3,550
21,160F
24,710
V
7000
W
X
16,940
Y
11,600
Z
12,800
10,580F
23,380
AA
4,000
10,580F
14,580
ZONE 23
A
9080
B
4,980
21,160F
26,140
C
1,830
10,580F
12,410
D
7530
E
3020

Figure II-12. 1971 vehicle miles traveled in Seattle CBD. Freeway VMT's are indicated by the letter F. Approximate locations of monitoring stations are shown by the symbol △.

distribution of daily VMT's by subgrid for the CBD. It appears from this distribution that the Municipal Building Monitor (Subzone Z) receives large contributions from both local city streets and from the freeway, whereas the Westlake Mall monitor (Subzone M) is less influenced by freeway emissions. The average VMT for Subzones 21-Z, 23-A, and 23-B is 19,533, and the average VMT for Subzones 21-M and 21-S is 12,935. The ratio of these VMT's is 1.5, whereas the average ratio between 8-hour maximum concentrations measured by the two monitors over corresponding periods was 2.0. We believe that the difference in concentration at the two sites reflects both a difference in area-wide emissions affecting the sites, and a somewhat more open exposure at the Westlake Mall trailer site.

The proportional modeling in the following section is based on the second-highest, 8-hour average concentration at the Municipal Building and the average emission density for Zone 21. We consider the development of control strategies from these data to be a sound, but conservative, approach to the reduction of CO levels in Seattle. Verification of the baseline concentration at other carefully selected locations within the CBD is highly desirable.

b. Results

Table II-23 summarizes relevant emission density and air quality data for Zone 21. According to these estimates, a 12.7 percent reduction in vehicular emissions from 1971 levels is required from transportation control strategies.

TABLE II-23

SUMMARY DATA FOR ZONE 21 (CO)

a) Emission Densities (kg/8hr/mi^2)

	YEAR	
Category	1971	1977
Vehicular	14,301	8,175
Non-Vehicular	292	292
Total	14,593	8,467

b) Air Quality (8-hr average in ppm)

	YEAR	
	1971	1977
Observed (2nd highest)	20	
Estimated		11.6

c) Maximum Allowable Emissions Level (kg/8hr/mi^2)

Total	Non-Vehicular	Vehicular
6,567	292	6,275

d) Reduction in Vehicular Emissions from 1971 Levels

	PERCENT
From Federal Motor Vehicle Control Program by 1977	43.4
Additional Required by Transportation Control Strategies	12.7

The maximum allowable vehicular emissions level is 6275 kg/8-hr/mi^2. Figure II-11 shows that the 1977 emission levels expected as a result of the Federal Motor Vehicle Control Program are well below this acceptable level except for Zone 21. In Tacoma, the highest 1977 emission density is approximately one-half of the allowable level.

3. Estimation of Oxidant Levels

a. Emission Densities within Core Area

For the proportional modeling used to estimate air quality for 1977, it is necessary to apportion the total initial hydrocarbon content of the local air mass within which the highest oxidant concentrations are produced to vehicular and non-vehicular sources. No spatial relationship between the source of the hydrocarbons and the region of high oxidant concentrations need be postulated. The following basic assumptions were used in making the apportionment:

(1) The local air mass of concern is the one having the highest hydrocarbon content. It's source is the central Seattle region defined by Zones 7 through 29, where maximum vehicular emissions occur.

(2) Hydrocarbons from non-vehicular sources are uniformly distributed throughout the city of Seattle.

(3) The amount of hydrocarbon emissions within Seattle is directly related by population to total emissions within King County.

Vehicular Emissions - Figure II-13 shows 1971 and 1977 three-hour hydrocarbon emission densities calculated for the Seattle area from the traffic data in Appendix A. Emission densities for 1970, 1971, and 1977 are listed by vehicle type in Appendix B. The emission densities for 1970 were calculated by increasing the 1971 VMT's by 2.5 percent.

Total 1970 hydrocarbon emissions for the 23 square mile area comprised of Zones 7 through 29 during the 0600-0900 period were 7052 kilograms. When adjusted on the basis of traffic flow, this is equivalent to 39,842 kilograms per day.

Non-Vehicular Emissions - Table II-24, compiled from the emission inventory data in Appendix C of the Implementation Plan, gives the distribution of hydrocarbon emissions, by source category within King County in 1970. The non-vehicular emissions attributed to Seattle were calculated from the County emissions by population as follows:

$$\begin{aligned}\text{City Emissions} &= \text{County Emissions} \times \frac{\text{City Population}}{\text{County Population}} \\ &= 35{,}969 \times \frac{530{,}831}{1{,}156{,}633} = 16{,}608 \text{ tons/yr}\end{aligned}$$

These emissions were assumed to be evenly distributed throughout the city (76.4 mi^2) and emissions from the central 23 square mile area was calculated to be 4,970 tons/year or 12,352 kg/day using this assumption. Based on these very rough approximations, the non-vehicular emissions make up 24 percent of the total hydrocarbon emissions within the central area. Table II-25 gives estimated 1970 and 1977 hydrocarbon emission rates for the Puget

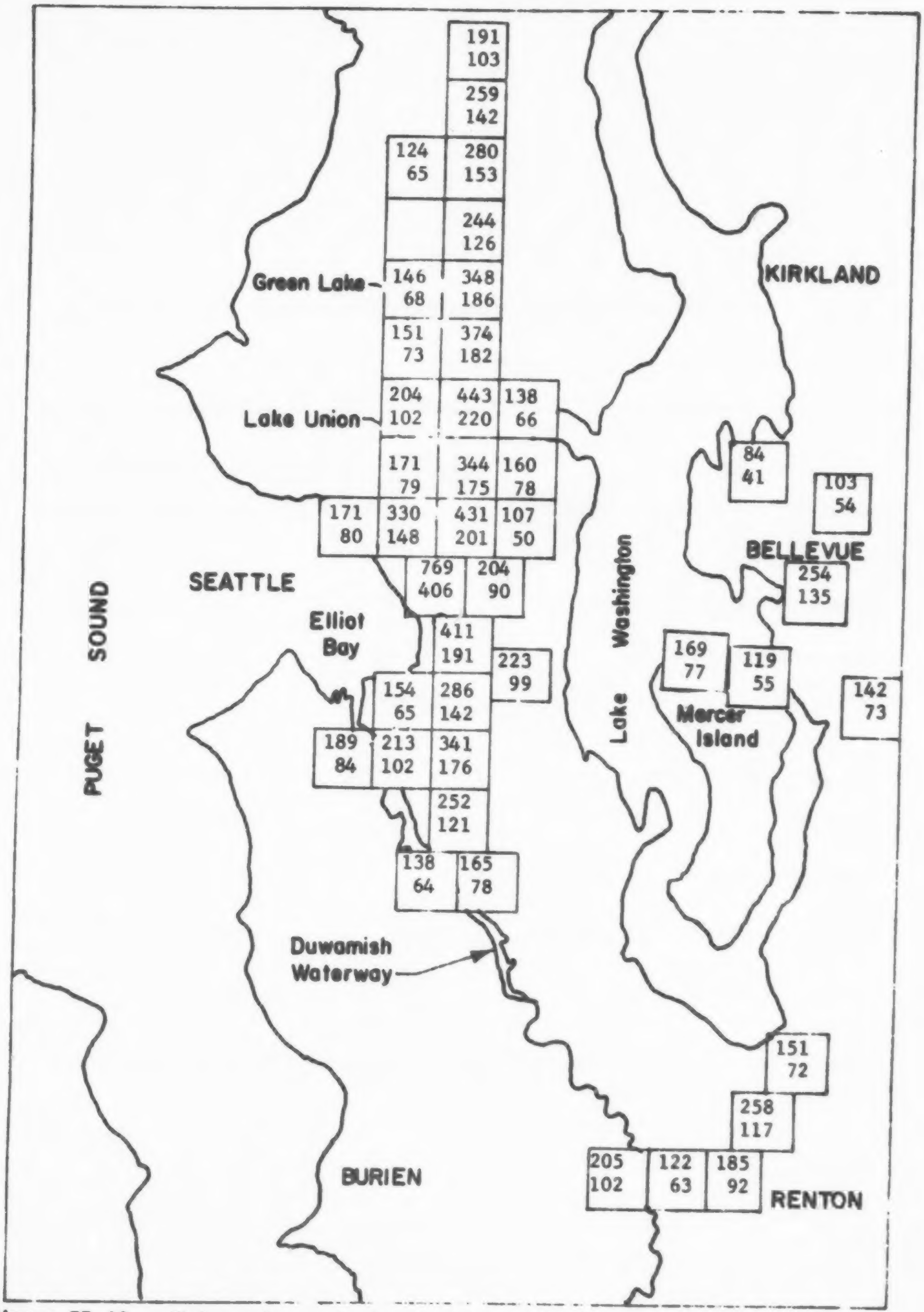
191 103
259 142
124 65
280 153
244 126
KIRKLAND
Green Lake
146 68
348 186
151 73
374 182
204 102
443 220
138 66
Lake Union
84 41
171 79
344 175
160 78
103 54
171 80
330 148
431 201
107 50
BELLEVUE
769 406
204 90
254 135
SEATTLE
PUGET SOUND
Elliot Bay
Lake Washington
411 191
223 99
169 77
119 55
142 73
154 65
286 142
Mercer Island
189 84
213 102
341 176
252 121
138 64
165 78
Duwamish Waterway
151 72
258 117
BURIEN
205 102
122 63
185 92
RENTON

Figure II-13. Hydrocarbon emission densities (KGM/Sq. Mi.) in Seattle for 6 A.M. - 9 A.M. period. Upper values are for 1971, lower values are 1977 emissions based on Federal Motor Vehical Control Program.

TABLE II-24

HYDROCARBON EMISSION ESTIMATES FOR KING COUNTY IN 1970

SOURCE CATEGORY	EMISSION (TONS/YEAR)	
Fuel Combustion	2126	
Process Losses	7959	
Solid Waste Disposal	2100	
Transportation		
Motor Vehicles	118,283	
Aircraft	3,066	
Other	20,146	
Miscellaneous Area	572	
Subtotal (non-vehicular)	35,969	(23.3%)
Total	154,252	

TABLE II-25

HYDROCARBON EMISSION ESTIMATES FOR PUGET SOUND INTRASTATE A.Q.C.R.

SOURCE CATEGORY	EMISSIONS (TONS/YEAR)	
	1970	1975
Process Losses	13,520	13,520
Fuel Combustion	4,623	4,623
Transportation*		
Motor Vehicles	185,791	124,391
Other	36,447	36,447
Solid Waste Disposal	5,100	3,075
Miscellaneous Area Sources	1,736	1,636
Subtotal (Non-Vehicular)	61,426	59,301
Total	247,217	183,692

---

* 1970 values have been distributed in accord with breakdown given in King County 1970 estimates (Appendix C, Implementation Plan). "Other" transportation emissions are left unchanged for 1975.

Sound Intrastate A.Q.C.R. The sum of the non-vehicular sources shows a slight decrease between 1970 and 1975. In the proportional modeling which follows, non-vehicular hydrocarbon emissions in the area of concern are assumed to be 24 percent of the total in 1970 and to remain constant throughout the 1970-1979 period.

Selection of Air Quality Baseline - Table II-10 shows that the highest oxidant concentrations observed within the Seattle area were measured at the I-5 and Dearborn sampling station. However, as mentioned in Section II-B, the average diurnal variation of concentration at this site showed a rapid rise from 0500 to 0800 in the morning and maximum concentrations toward the end of the afternoon and early evening. Also, the maximum one-hour concentration observed during each of the four months of the sampling increased steadily from July to October. This behavior, which is not typical of the behavior of photo-oxidants, plus the fact that the monitor was located at a major freeway, has raised questions concerning the representativeness of the data. In evaluating the oxidant problem, we have, therefore, chosen to disregard the 1970 data from I-5 and Dearborn and to rely on the more recent data taken at the four widely distributed sites in operation during the summers of 1971 and 1972.

b. Results

Table II-26 summarizes the results of the proportional modeling of hydrocarbons based on the second-highest, one-hour oxidant concentration observed in the Seattle area in 1971 and 1972 and hydro-

TABLE II-26

SUMMARY DATA FOR CENTRAL 23 SQUARE MILE AREA (HYDROCARBONS-OXIDANTS)

a) Emission Rates of Hydrocarbons (kg/3hr/23 mi^2)

	YEAR	
	1971	1977
Vehicular	6,308	3,063
Non-Vehicular	2,227	2,227
Total	8,535	5,290

b) Air Quality - Oxidants (1-hr average in ppm)

	YEAR	
	1971	1977
Observed (2nd Highest)	0.11	
Estimated		< 0.08

c) Maximum Allowable Emission Level of Hydrocarbons (kg/3hr/23mi^2)

Total	Non-Vehicular	Vehicular
6316	2227	4089

d) Reduction in Vehicular Emission of Hydrocarbons from 1971 Levels

	PERCENT
From Federal Motor Vehicle Control Program by 1977	51
Additional Required by Transportation Control Strategies	0

carbon emissions within the 23 square mile central zone of the city. Estimates of air quality and allowable emission rates were made by means of the curve given in Appendix J of 42CFR, Part 420.

The estimates in Table II-26 show that the hydrocarbon emission rate expected in the central area (5290 kg/3-hr/23 mi^2) is 16 percent below the maximum allowable rate. In our judgment, the data available at the present time indicate that photochemical oxidants in the Seattle area will fall within the national standards by 1977 without the imposition of special transportation control strategies.*

E. PROJECTED CARBON MONOXIDE LEVELS IN 1978 AND 1979

Vehicular CO emission densities in 1978 and 1979 were calculated for the CBD, using projected VMT's and the appropriate emission factors, on the assumption of no additional transportation control strategies. The results are given in Table II-27. These estimates indicate that the national standards for CO will be met by 1979 by means of the Federal Motor Vehicle Control Program.

---

*The use of the I-5 and Dearborn 1970 oxidant data (2nd highest, 1-hour average concentration of 0.15 ppm) and the 1970 vehicular emission rates given in Appendix B (7052 kg/3 hr./23 mi^2) yields a required total reduction in hydrocarbons of 5 percent, and a required reduction by transportation control strategies of 6.6 percent.

TABLE II-27

PROJECTED CO EMISSION LEVELS IN 1978 AND 1979, WITHOUT STRATEGIES

SOURCE CATEGORY	EMISSION DENSITY (kg/8hr/mi^2)		
	Allowable	1978	1979
Vehicular	6275	6951	6001
Non-Vehicular	292	292	292
TOTAL	6597	7243	6293

F. SUMMARY OF PROBLEM AND CONCLUSIONS

1. Implementation Plan Assessment of CO and Oxidant Problems

The assessments of the CO and oxidant problems in Seattle and environs made in the Implementation Plan were based on procedures specified in Appendix I of the Federal Register, Vol. 36, No. 153, pp. 15500-15501. The degree of improvement in air quality needed for attainment of the national air quality standards was made by the proportional model

$$\frac{(A - C)100}{A - B}$$

where A = the second highest concentration observed over the period of observation;

B = the air quality standard;

C = the background value, set equal to zero.

The formula for calculating the air quality level for some future year, as specified in Appendix I is:

$$A.Q._1 = A.Q._0 \; \frac{E_1}{E_0} \; F_0 + (1-F_0)(G\ F)$$

where:

Subscripts 0 and 1 denote the base year and future year of interest, respectively.

A.Q. = Air quality (measured or estimated) in region

E = Normalized emissions from Figures 1 and 2 in Appendix I

F = Ratio of motor vehicle emissions to total emissions of each pollutant in region

GF = Growth factor for emission increases from stationary sources

This equation was applied directly for carbon monoxide. The percent reduction in hydrocarbon emissions expected from the Federal Motor Vehicle Control Program was estimated by the portion of the equation in brackets and compared with the percent reduction required to meet the standard for photochemical oxidants obtained from Appendix J of the same Federal Register (p. 15502).

The rollback calculations for both CO and oxidants were based on the 1970 observations made at I-5 and Dearborn. These calculations indicated that a 20 percent reduction in CO and a 7 percent reduction in hydrocarbon emissions from 1970 levels would be required to meet the national standards, in addition to the reductions expected through the Federal Motor Vehicle Control Program. Reservations were made about the use of the CO and oxidant data from this location, in the rollback calculations, and the need for more complete and reliable information before a valid assessment of the problem could be made was pointed out. The limited data from other sources indicated that the CO standards would be met in 1977 by means of the Federal Motor Vehicle Control Program, and that the oxidant standard was currently being met. In its review of the Implementation Plan, the Division of Air Surveillance, EPA, expressed the opinion that rollback calculations for the region should not be based on 8-hour average concentrations from the I-5 and Dearborn site, but that, because of the very limited oxidant data available upon which to base the need for transportation controls, the oxidant data measured between 0900 and 1600 PST should be considered.

2. Current Assessment of CO and Oxidant Problems

As explained earlier in Section II, it was decided to take full advantage in the present study of all data currently available and to shift the base year to 1971. The use of the more comprehensive set of air quality data collected since submission of the Implementation Plan is believed to increase substantially the reliability of the baseline concentrations used in projecting air quality and estimating rollback requirements. The results of this reassessment of the problem may be summarized as follows:

(1) The national oxidant standard will be attained throughout Seattle and environs by 1977 without the use of transportation control strategies.

(2) The national CO standards will be attained throughout Seattle and environs by 1977 without the use of transportation control strategies except within the CBD.

(3) Attainment of the 8-hour CO standard within the CBD will require a reduction in CO emissions by transportation controls of 13 percent from 1971 levels. This is equivalent to a reduction of 23 percent from the 1977 "no strategy" emission level.

(4) The Federal Motor Vehicle Control Program will ensure that the national CO standards will be met by 1979 without the use of transportation control strategies.

(5) In Tacoma, the calculated reduction in motor vehicle emissions between 1971 and 1977 is approximately 43 percent, and the 1977 vehicular emissions within the CBD are about half the level allowable in the Seattle CBD.

In summary, the current assessment of the problem, based principally upon air quality data collected since the submission of the Implementation Plan, indicates that the oxidant problem in the Seattle area is less severe than initially thought and will not require the imposition of transportation control strategies. However, the recent CO data collected at the Municipal Building in the Seattle CBD indicates a local problem that will require a decrease in CO emissions within the CBD greater than that anticipated from the Federal Motor Vehicle Control Program.

III. EVALUATION OF CANDIDATE TRANSPORTATION CONTROLS

A. GENERAL

The proportional analysis carried out in Section II indicates that by 1977 the motor vehicle pollution problem in Seattle and its environs will be limited to CO concentrations in the CBD. The reduction in CO emissions required from transportation control strategies to ensure that the national standards be met was estimated to be 13 percent from 1971 levels, or 23 percent from the 1977 "no strategy" level. Preliminary estimates showed that meeting this goal would require the joint implementation of a number of the most feasible transportation controls, and a list of potential strategies was developed for initial screening. These strategies, and preliminary estimates of their impact on air quality, are discussed in Section B, below. The estimates of emission reductions in these evaluations are from the 1977 "no strategy" level.

The list of potential strategies is shown in Table III-1 arranged into groups by a feasibility rating. These groupings were decided as a result of discussions with representatives from the City of Seattle, Washington State Highway Department, and Washington State Department of Ecology.

Simply stated, the strategies listed in Group II through V are not applicable because they are too long-range, not practical in downtown Seattle, or run counter to present local and statewide policy.

TABLE III-1

POTENTIAL STRATEGIES BY FEASIBILITY GROUPING - SEATTLE AREA

I. Strategies for Evaluation:

a. Continue to support the METRO transit development program.

b. Develop fringe parking with PRT links to downtown.

c. Develop incentive programs for retrofit (and inspection) of heavy-duty fleet vehicles.

d. Encourage gaseous conversion for fleet vehicles.

e. Implement the proposed I-5 surveillance, control, and ramps metering program.

f. Develop means to bypass through traffic in downtown.

g. Driver advisories directed to parking and loading.

h. Plan to exploit opportunities to encourage car pools, staggered hours, and staggered day programs.

i. Improved signal systems.

j. Support incentive programs to discourage ownership of older, uncontrolled vehicles.

II. Strategies of Doubtful Effectiveness in Downtown:

a. Air watch driver advisory.

b. Regional area traffic bypass.

c. Fuel additives.

III. Strategies Outside Policies and Goals for Downtown:

a. Increase in parking fees.

b. Large-scale parking prohibitions without replacement elsewhere.

c. Large-scale vehicle prohibitions.

TABLE III-1 (Cont.)

- d. Limitations in street capacity.
- e. Computer controlled signal system.
- f. Controls on pedestrian movements.
- g. Additional one-way or reversible streets.
- h. Large-scale street capacity increases.

IV. Strategies for Long-range Consideration, but Effective Only Beyond 1977:

- a. New-type vehicles.
- b. Communications substitutes for travel.
- c. Land use policies.
- d. Planning of facilities to reduce emissions.

V. Strategies Outside Present Policy Framework:

- a. Impose tolls.
- b. Fuel rationing.
- c. Increased user taxes and fees.
- d. Road use taxes.
- e. Rationing of vehicle ownership.
- f. Inspection and maintenance of all vehicles.

Increases in parking fees and large-scale prohibitions of parking and vehicles themselves seem far from practical from the standpoint of downtown business. Such steps might become practical only as part of programs to replace parking using fringe parking with equally convenient access.

Strategies such as prohibiting or imposing tolls on older, uncontrolled vehicles are viewed as discriminatory. Street capacity improvements, particularly signal improvements, are considered acceptable to relieve hot spot problems, reduce idling, or solve safety problems. However, improvements with the aim of accommodating more vehicles in downtown appear to be counter to the present thrust of planning for downtown Seattle. Also, the development of an elaborate computer-controlled signal system for downtown falls very low in priority due to high cost and the need to improve and develop signal systems in areas other than downtown.

Land use policies can be an important tool for downtown by encouraging second-level sidewalks, parking control, and building bulk control (perhaps to improve air circulation). The impact, however, is long-range. In the meantime, all significant improvement projects should be reviewed for their air quality impact.

B. STRATEGY EVALUATION

Group I in Table III-3 includes a fairly extensive list of activities that can become elements of one or more candidate strategies for Seattle. The strategies discussed in the following paragraphs are recommended candidates for inclusion in any air quality implementation plan for Seattle - either in total or in part.

1. Continue to Support the METRO Transit Program

The METRO Transit Plan was described briefly in Section II C since the elements of the Plan expected to be operating in 1977 were used to estimate the 1977 vehicle miles of travel. Generally speaking, there was little impact estimated from the new transit system on arterials, but new express service was estimated to have an important effect on freeways. Freeway vehicle miles were cut back from levels based on past trends in the central business district and elsewhere. Surface street trips in downtown, on the other hand, were not. Therefore, it seemed important to investigate this impact in more detail.

Several approaches were tried. Background work for Draft Environmental Impact Statement for the Metropolitan Area Transit Plan; Cornell, Howland, Hayes, and Merryfield, June 1972; estimated that peak hour modal split for downtown would increase from 21.7 to 34.9 percent. This large increase in the transit share of trips to downtown is equivalent to a condition where transit absorbs all growth and vehicle miles remain the same as 1971. This is equivalent to a further reduction in emissions from the calculated 1977 level of some 8 percent.

However, the forecasts of transit travel in 1980 across various screenlines including one surrounding downtown Seattle, indicate that growth in transit passengers may be much more modest. Therefore, an estimate was made keeping local transit route loadings the same as 1971, but calculating express transit use with mode split curves developed in the evaluation of the Blue Streak Bus Rapid Transit Demonstration Project. These curves are illustrated in Figure III-1.

In addition, several assumptions relating to regional travel were made:

(1) The park-ride lots will be located an average of 12 miles from downtown.

(2) The starting point of these trips would approximate the same distribution of trip lengths as found in the Blue Streak corridor north of downtown Seattle.

(3) Average auto speed to downtown will be 47 mph, and transit travel time will be 1.5 times auto travel time.

With such assumptions, it was calculated that 11 percent of 195,000 daily trips would be attracted to the express bus park and ride system.

These trips had already been deducted from freeway volumes in the downtown area. However, the portion of the vehicle miles representing travel from the freeway to parking was not accounted for in the 1977 estimates. This amounted to 4,000 vehicle miles during the 8-hour period. Deducting this from the 8-hour vehicle miles results in an emissions reduction of 2.2 percent. This figure is judged to be a fair evaluation

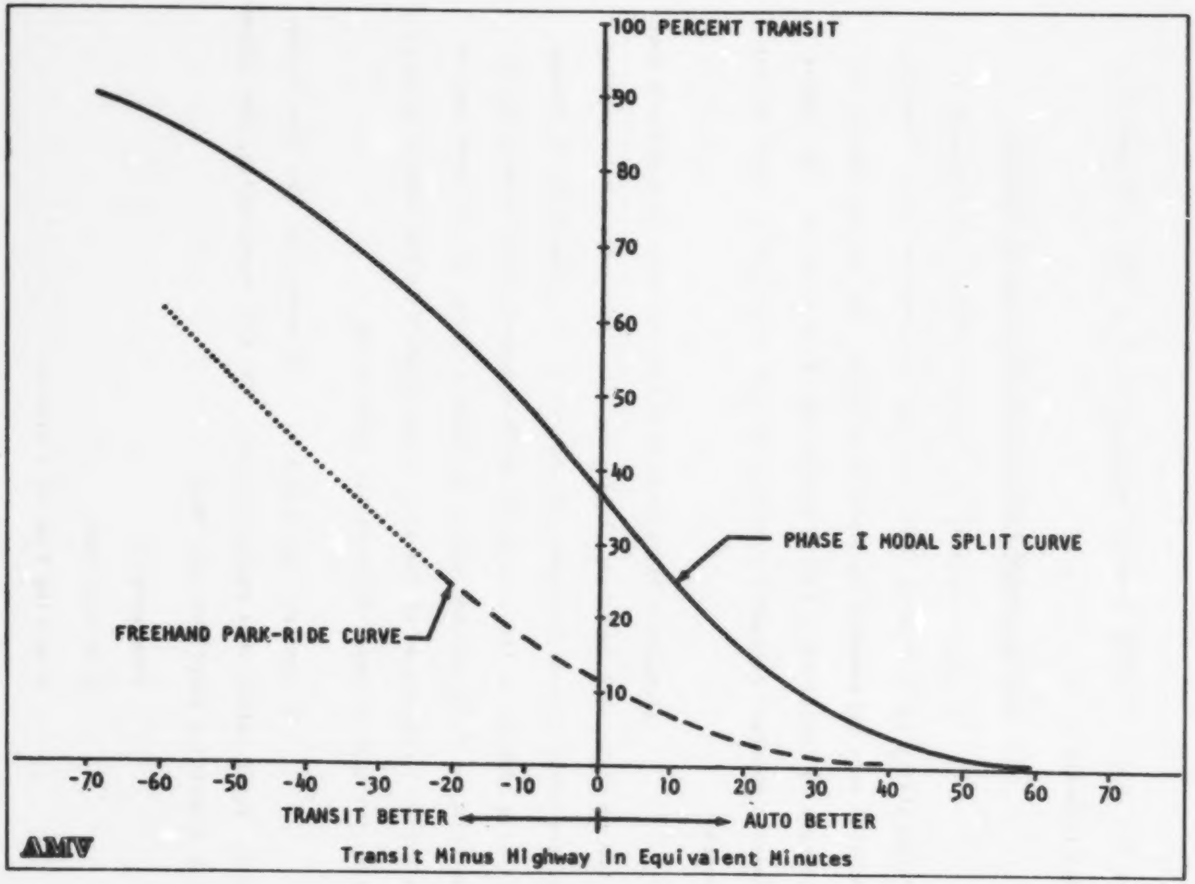

Figure III-1. Blue Streak mode split curves.

of the impact of METRO Transit, although it is in the lower part of the terminal.

2. Develop Fringe Parking with PRT Links to Downtown

Serious consideration is being given to development of Personalized Rapid Transit (PRT) in Seattle's downtown area. "People-movers" were recommended in previous studies. The Boeing Company of Seattle is installing a PRT in Morgantown, West Virginia. The famous Seattle Monorail presently connects downtown and Seattle Center to the north.

Although a PRT system oriented east-west in Seattle's downtown could be very important in linking vital land uses and overcoming severe topographical barriers, the potential for connections to fringe parking appears to lie in a north-south oriented system connecting to an existing 2,000 parking spaces at Seattle Center on the north and to a future 1,800 spaces at the King County Stadium on the south. A location for such a system is presently under study.

To evaluate the impact of a PRT park-ride, the Blue Streak mode split curves were again utilized. For this application, the following generous assumptions were made:

- Free parking
- A 20-cent fare
- A waiting time of 5 minutes
- An average PRT speed of 30 mph

Diversion from auto to PRT was tested for autos approaching via I-5 from the north, Aurora Avenue from the north, Elliott Avenue from the northwest, I-90 from the east, and 1st Avenue from the south. Modal splits of 16 percent to 20 percent were calculated with the low cost assumptions. This would mean a large number of daily trips diverted, probably exceeding the capacity of the 3,800 spaces available and planned.

Diversion of 3,800 trips in the critical 8-hour period is very likely since users of the PRT will probably be downtown workers. Such a diversion would reduce vehicle miles in downtown (with only a slight increase in adjacent areas) and produce an emissions reduction of 1.9 percent.

It must be pointed out that a bus park-ride already exists at the Seattle Center, but without the high PRT level of service. Also, it must be noted that the planning, financing, design, construction, and commencement of operations for the PRT by 1977 are unrealistic. Although only a slight reduction in emissions is estimated for 1977, the potential appears to be much, much greater. However, obstacles to implementation by 1977 are also great, as described in Section V.

3. Incentive Retrofit Programs

The retrofit program for heavy-duty fleet vehicles has been suggested by the Department of Ecology and would be acceptable to City Officials as an incentive-type program.

A 58 percent reduction in carbon monoxide emissions from light duty vehicles is cited by EPA* for an "air bleed to intake manifold" device, available at a nominal $40 cost. Estimates place the portion of uncontrolled heavy-duty vehicles at between 45 and 55 percent of total heavy-duty vehicles by 1977. For Seattle, heavy-duty gasoline vehicles produce approximately 21 percent of the carbon monoxide emissions. Assuming an identical effect on heavy-duty vehicles, the potential impact could be:

$$(0.21\ \text{emissions})(0.58\ \text{reduction})(0.50\ \text{uncontrolled}) = 0.062 = 6\ \text{percent.}$$

If only fleet vehicles are regulated (about 9 percent of all trucks are in fleets of 10 or more) the potential reduction would be approximately 0.4 percent.

Advantages to such a program could be its ease of administration and enforcement as compared to retrofit of all older vehicles, and its relatively low cost. However, an evaluation of the effectiveness of such a device on heavy-duty vehicles has not been made but EPA, and its acceptance as a strategy requires justification. Development of such a program would require the support of the City of Seattle and other agencies.

4. Gaseous Conversion

Present legislation in the State of Washington provides a tax incentive for conversion of vehicles to liquified natural gas (LNG) or liquified petroleum gas (LPG). Like retrofit, this program is best suited to fleet operation. Reductions in emissions for light-duty vehicles range from 65 to 90 percent,[*] and similar reductions are assumed for heavy duty. Considering the percent of emissions from each class, overall reductions could be:

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*Control Strategies for In-Use Vehicles, Office of Air and Water Programs, Mobile Source Pollution Control Program, Washington, D.C., November 1972.

- Heavy-duty, fleets of 10 or more: 1.1 percent
- Light-duty, fleets of 10 or more: 0.7 percent
- Light-duty, fleets of 10 or more plus all government: 2.2 percent

Similar to the retrofit strategy, this program would require the support of many agencies to extend legislation providing the incentive and to develop a public relations program aimed at fleet owners.

5. Implement the Proposed I-5 Surveillance, Control and Ramp Metering Program

Like METRO transit, this strategy is mentioned in Section II C but with the suggestion that it be considered as a candidate strategy if air quality problems are identified in the I-5 corridor. Such a problem has not been identified for 1977, but the impact of the freeway control project from downtown north has been evaluated as far as it may impact on downtown.

Essentially, the project is designed to limit peak volumes on I-5 to a level where 50 mph average speeds will result. This will be accomplished mainly through ramp metering where an approaching motorist will face a green or red light depending on the traffic density on the freeway itself. The signal control of ramps will assist with merging, will allow express transit access without delay via a bypass lane, and will divert "excess" vehicles to parallel arterials. This would cause some additional VMT on these arterials, however.

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[*] Preliminary EPA estimates. Actual emission reductions have been found to vary widely. See Control Strategies for In-Use Vehicles, pp. 4-3 to 4-5.

In areas where this system is in operation, increases in traffic volumes on parallel surface routes have not been detected. Nevertheless, the presence of diverted traffic on parallel arterials has been assumed for this analysis. Growth of freeway volumes to 1977 has been estimated for all hours of the day. Any hourly volume exceeding 1969 levels (representing the capacity of I-5) was then manually assigned to parallel arterials such as Aurora Avenue.

In downtown, the effect of this is to increase peak period vehicle miles on north-south arterials and decrease vehicle miles on the freeway and east-west streets connecting to ramps.

The net effect on downtown is calculated as an even balance, with no reduction in emissions.

6. Develop Means to Bypass Through Traffic in Downtown

In the report 1970 Study of Traffic and Parking in Seattle's Central Business District, Seattle Traffic Engineering Division, two types of through traffic were identified. It was calculated that 20 percent of the volume to and from I-5 travels through downtown to park on the west side. Bypassing this traffic would seem to require new facilities providing access to the west side of downtown. Development of such facilities by 1977 certainly must be considered doubtful, especially in view of the voter defeat of the Bay Freeway (east-west service between I-5 and the Alaskan Way Viaduct). Should such bypass routes, which together could serve as a ring road around the downtown area, be constructed, however, a partial traffic free zone, such as that in effect in Gothenburgh, Sweden, might be developed.

The study identified a through traffic volume of 17,250 and a total inbound volume of 175,600. If it is assumed that this through volume includes several components such as north to south, north to east, and south to east; the magnitude of each component can be estimated in direct ratio to total volume on the respective sides of downtown. Doing so indicates that the north-south component should be about one-third of the total.

If this volume is bypassed to I-5 (through some combination of impedance in downtown and improvement of the bypass route), it is estimated that vehicle miles will actually increase , with emissions up 1.9 percent.

The problem of through traffic in downtown would seem to be relatively small, and bypass of such traffic not a profitable strategy for improving air quality.

7. Driver Advisories

Some sort of driver information system to guide vehicles to parking and to curb loading zones may be effective in reducing the downtown "search for parking" vehicle miles. In 1968, Los Angeles found 22 percent of downtown travel during peak periods to be of this type. Assuming 10 percent effectiveness of such a program (it could include information brochures, fixed signs, or changeable message sign systems) and a 20 percent share of downtown traffic affected, a reduction in total downtown 8-hour emissions of 1.3 percent was estimated.

8. Car Pools, Staggered Hours, and Staggered Days

Although there are no large-scale plans for such programs, and voluntary programs are favored, a considerable potential exists for the use of car pools and staggered days in solving the 8-hour CO problem. Staggered hours might help peak hour (or half-hour) air quality, but probably would not move significant vehicle miles of travel outside of the 8-hour period or even into hours of higher travel speeds.

Car Pools - This technique is one that is frequently mentioned as a means to reduce vehicular travel demand, but is seldom found in actual practice except at large employment centers.

A practical maximum vehicle occupancy from a car pool program is 1.7 persons per car average, and 1.6 is more realistic. Based on the 1970 survey of downtown traffic, present occupancy is about 1.3. With an increase of occupancy from 1.3 to 1.6, vehicle miles could be reduced about 11 percent. If a car-pool program included only government employees (about one-third of downtown employment) the reduction could still be 3.6 percent. Realistically, a lesser effectiveness must be assumed, but the potential certainly exists.

A car pool program could be approached from several standpoints. Incentives are important in terms of preferred parking location and access to any reserved lanes (such as exclusive bus lanes on streets, freeways, or ramps). The second method has real potential in Seattle with the existing exclusive bus ramp at Columbia-Cherry Streets, and the proposed exclusive bus lanes on the Lake Washington bridges.

Publicity is another factor, along with a "matching" service to locate travellers with close-by origins and destinations.

Staggered Days - This program involves a four-day work week or similar approach. The effect could be removal of employee work trips from downtown on the fifth day - the "off" day.

The "4-40" plan has been implemented in some areas, usually on an experimental basis. Initial implementation on a large-scale could be with government employees. To be effective, the plan would have to spread the "off" day evenly throughout the week. Assuming 100 percent compliance (unlikely), the daily 20 percent employee reduction would produce a maximum reduction in vehicle miles of 9.6 percent. As with car pools, a lower level of effectiveness must be assumed although the potential is there.

9. Improved Signal Systems

The City of Seattle is about to implement and test a "SIGOP" project. This project involves use of a computer program to prepare timing plans for the existing downtown signal system that will improve traffic flow through better progressive speeds. The program is experimental, and a major product of the operation is an evaluation of just what improvements do result. However, the goals of the SIGOP program may be a fair indication of what might be achieved in terms of improving air quality.

With implementation of SIGOP, progressive speeds ranging from 15 mph on steep crosstown routes to 30 mph on major downtown arterials (these goals expressed to the nearest 5 mph) might be achieved. With allowance for the difference between progressive speed and actual average speed (less), improvements in average speed are indicated for some streets in the 18 mph and 20 mph categories used in the 1977 estimate. Calculating the effect of these speed changes resulted in an estimated emissions reduction of 6.2 percent.

10. Discourage Use of Older Vehicles

This strategy could be directed towards an incentive program to remove older, pre-controlled vehicles from the traffic stream. By 1977, vehicles of 1966 vintage and older will probably have reached their minimum value. Therefore, a program to offer a "bounty" of $100.00 or so to scrap such vehicles might encourage owners to obtain and use newer model autos.

Such a program would undoubtedly have to be approached on a Statewide basis, or at least through State legislation. Financing such a program might be done by increasing user taxes or taxes on new vehicles. An additional benefit to this program would be improvement in visual pollution. The pay-off for such a program in terms of reduced pollution could be high, up to 20 percent.

C. SUMMARY AND IMPACT

The strategies discussed above are ranked in Table III-2 based on the combination of reduction in emissions provided and the potential for implementation. The impact of each strategy is listed under several categories. Two strategies evaluated, bypass of downtown through traffic and the I-5 control project, are deleted as not effective. Rather than attempt to stipulate one strategy as being a higher priority than another, the rankings are by groups.

As mentioned earlier, prohibiting the use of older vehicles is viewed by the various state and local agencies as discriminatory. However, because of its high potential for reducing emissions, the exclusion of older model vehicles from the CBD has been included in Table III-2, and its potential evaluated in the following section. Its use is suggested if an incentive program to discourage the use of older vehicles fails.

TABLE III-2

SUMMARY AND EVALUATION OF STRATEGIES FOR REDUCTION OF CO EMISSIONS

Rank	Strategy	Emission Reduction (from 1977)	Implementation Potential	IMPACT						
				Cost	Political	Economic	Institutional	Legal	Social	Technical
1	Support METRO Transit development	2.2% and up	High	High (Funded)	Tax Support Approved. Favorable Image	Usually a deficit activity	Public ownership in process		Highly favorable to low income groups	
	Develop fringe parking and PMT	1.9% and up	Moderate to high	High	Favorable image. Requires federal support	Utilizes available parking. Favorable to downtown activities.		Operating agency must be selected.	Could encourage inner city residential development.	Demonstration underway.
	Improve downtown signal system	4.2%	High	Low	May not be part of downtown goals & objectives					Emission reduction could be short-term.
	Retrofit heavy-duty fleet vehicles	0.5%	Moderate	Low unit cost	Should be an incentive program.		Small identified group for administration.	Present legislation must be extended past 1975.		Air bleed to intake manifold available
	Exclusion of pre-controlled vehicles	Up to 20%	Low to Moderate	Low	Unfavorable	May divert some business from downtown	Adds to administrative burden.	Legislation required.	Discriminatory.	Requires enforcement.
2	Gaseous conversion of fleet vehicles: Light duty Heavy duty	0.7% to 2.2% 1.1%	Moderate	High Unit Cost	Favorable image for fleet operator. Should continue incentive program.		Small identified group for administration.	Present legislation must be extended past 1975.		Fuel handling and some maintenance problems. Potential shortage of natural gas.
	Program to discourage ownership of older, pre-controlled autos	0% to 20%	Low to Moderate	High	Probably requires tax increases. Will assist with beautification.		Adds to state administrative burden.	Legislation required, statewide or specific area.	Should improve mobility for low income groups.	Requires towing disposal means.
3	Driver advisories guiding to parking	1.3%	Low to Moderate	Moderate to Low		Could improve downtown environment				Tech. of advanced systems may require development.
	Car pools	0% to 6.0%	Low	Low	Strong agency support required.		Public relations program required.	Access to reserved lanes and ramps must be approved. Enforcement problems.	Public attitudes must be altered.	Rider "matching" program required.
	Staggered days	0% to 9.0%	Low	Low		May impact some businesses.	May not be popular with long weekends. Requires public relations program.	Labor laws may be obstacles.	Changes life style	

IV. SELECTION OF TRANSPORTATION CONTROLS AND ESTIMATE OF AIR QUALITY IMPACT

The first three strategies listed under Rank 1 of Table III-2 result in changes either in the distribution of VMT's among the various speed categories, or in the total number of VMT's for certain speed categories. Estimates of VMT's by speed category after applying the three strategies in sequence are given in Table IV-1. These estimates were used to calculate 1977 emissions and the emissions converted to CO concentrations by the proportional model discussed in Section II-D. The results are shown in Table IV-2.

These estimates indicate that a further reduction of 1304 kg/8 hr/mi^2 will be required to meet the 8-hour standard. Judged by their potential for implementation (See Table III-2), the next two strategies for selection are retrofit heavy duty fleet vehicles, with an estimated yield of 41 kg/8 hr/mi^2 (0.005 x 8175), and the gaseous conversion of fleet vehicles. The estimated yield for conversion of light duty fleets of 10 or more plus all government light duty vehicles is 180 kg/8 hr/mi^2 (0.022 x 8175). Although useful, these two strategies combined contribute only about 17 percent of the 1304 kg/8 hr/mi^2 reduction required.

It appears from these that a strategy with much higher potential yield is required. Two strategies with high potential are the exclusion of pre-controlled vehicles from the CBD and a more general use of retrofit systems. Table IV-3, which gives the expected 1977 emissions after the application of Strategies 1, 2, and 3, provides a convenient means of

TABLE IV-1

VEHICLE MILES TRAVELED IN 1977 FOR SELECTED STRATEGIES

	8-Hour VMT			
		Strategies		
Average Speed (mph)	Without Strategies	1	1 + 2	1 + 2 + 3
50	79,736	79,736	79,736	79,736
25	1,300	1,300	1,300	1,300
24	0	0	0	51,807
20	96,240	92,968	89,168	51,977
18	22,079	22,079	22,079	7,463
12	23,172	23,033	23,033	23,033
15	881	881	881	881
Total	223,408	219,997	216,197	216,197

TABLE IV-2

IMPACT OF SELECTED STRATEGIES ON AIR QUALITY IN 1977

	Allowable	Without Strategies	With Strategies				
			1	1 & 2	1 & 2 & 3	1 & 2 & 3	
						Exclusion	Retrofit*
Vehicular Emissions (kg/8 hr/mi^2)	6275	8175	8032	7875	7579	6275	3830
8-Hr CO Conc. (ppm)	9.0	11.6	11.4	11.2	10.8	9.0	5.6

Key to Strategies

(1) METRO Transit Development.

(2) Fringe Parking and PRT.

(3) Improved Signal System.

* Example calculation based on: (1) "air bleed to intake manifold" on pre-1968 models, and (2) "oxidizing catalytic converter with distributor vacuum advance disconnect" on 1968-1974 models.

TABLE IV-3

1977 CO EMISSIONS IN THE SEATTLE CBD BY MODEL YEAR AND VEHICLE TYPE

	Emissions (kg/mi^2)	
Model Year	Light Duty	Heavy Duty
1965 and earlier	477	217
1966	302	32
1967	436	38
1968	524	58
1969	948	77
1970	675	116
1971	925	134
1972	439	180
1973	501	193
1974	477	117
1975	85	145
1976	73	186
1977	27	100
1978	2	3
Total	5891	1596

evaluating strategies that affect selected years or vehicle types. For example, pre-controlled light duty vehicles (pre-1968 models) contribute 1215 kg/8 hr/mi^2, and pre-controlled heavy duty vehicles (pre-1970 models) contribute 422 kg/8 hr/mi^2. Presumably, a policy of vehicular exclusion from the CBD would result, in part, in an increased use of public transportation systems, and, in part, in a shift in the age distribution of vehicles. For purposes of estimation, the following two assumptions have been made for pre-1968, light duty vehicle emissions:

1) Vehicle-trips contributing one-fourth of the emissions (304 kg/8 hr/mi^2) will be eliminated;
2) The remaining excluded vehicle trips will be replaced by trips made by more recent models: ½ by 1972-1974 models, and ½ by 1975 and later models.

The second assumption results in a drop in emissions of approximately 770 kg/8 hr/mi^2. Thus, the total decrease accomplished by the exclusion of light duty vehicles is 1074 kg/8 hr/mi^2, leaving a further required reduction of 230 kg/8 hr/mi^2. This reduction can be accomplished in a number of ways. For example, the use of the "air bleed to intake manifold" on light duty vehicles is estimated to yield a 58 percent reduction in emissions from a maintained baseline. A similar reduction in emissions from heavy duty vehicles (as yet undocumented) would yield a reduction of 262 kg/8 hr/mi^2 ($\underline{0.10 \times 422} + \underline{0.58 \times 380}$) if pre-controlled heavy duty vehicles were so equipped. It is also the approximate reduction likely to be achieved by excluding pre-controlled heavy duty vehicles from the CBD.*

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* Assuming an average reduction in emissions from pre-controlled to replacement vehicles of 45 percent.

Although the general use of retrofit systems and the establishment of the requisite inspection and maintenance facilities is not looked upon with favor in the State of Washington, computations based on Table IV-3 illustrate the potential impact of such a strategy. For example, the 1215 kg/8 hr/mi^2 contributed by pre-1968 light duty vehicles could be reduced by 755 kg/8 hr/mi^2 by the use of "air bleed to intake manifold" devices (assuming a 10 percent adjustment to a maintained baseline, and a 58 percent reduction due to the retrofit device*). Similarly, the use of an "oxidizing catalytic converter" on 1968-1974 light duty vehicles could yield a reduction of 2469 kg/8 hr/mi^2 (assuming a 50 percent reduction from a maintained baseline); or the use of the converter in conjunction with a distributor vacuum advance disconnect could yield a reduction of 2994 kg/8 hr/mi^2 (assuming a 63 percent reduction from a maintained baseline). Thus, the use of retrofit devices, in conjunction with the requisite annual inspection and maintenance, could easily provide the required reduction. In fact, the reduction of 3749 kg/8 hr/mi^2 accomplished by the two examples above is nearly twice the 1900 kg/8 hr/mi^2 reduction required by all strategies.

It is significant to note that, with the principal exception of the downtown signal system, the proposed strategies will lead to reduced area-wide emissions, and that their favorable impact on air quality will not be limited to the CBD.

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* See Control Strategies for In-Use Vehicles for percent reductions expected from retrofit devices.

V. OBSTACLES TO IMPLEMENTATION OF SELECTED CONTROLS

A. GENERAL

In general, the implementation climate for transportation projects in and around downtown Seattle seems to be more favorable towards projects that encourage public transportation than towards projects that favor private vehicle travel. This is in part due to the fact that, as in many urban areas, large highway and street projects are difficult to implement and require long lead times which effectively eliminate such strategies from consideration by 1977.

Again, in general, there seem to be few if any obstacles to implementation of a top-ranked strategy: development of the METRO transit system. The system is legally authorized, funded, planned and scheduled for development. Minor obstacles are:

- Many steps must be taken to start operation by January 1973. The time is short, but activity is intense. Acquisition of present transit systems is underway.
- There may be some technical difficulties in obtaining gaseous fueled buses, as desired, in sufficient quantity by the time desired.

Obstacles are catalogued in following paragraphs only for the top two priority groups where effective implementation seems to be a real possibility.

B. INSTITUTIONAL OBSTACLES

Planning, designing, and building a major project like one and one-half miles of PRT through a major downtown can involve a large number of institutional problems. While the general attitude towards such a project is favorable, individuals and groups are likely to be affected by the specific location. Also, the matter of jurisdiction must be solved. The choice would, in simple terms, be between the City and METRO as the sponsoring and operating agency.

The strategies of retrofit and gaseous conversion are both viewed with reluctance on the part of owners, particularly the small fleets. The success of these techniques is likely to depend on incentives offered and on a sound selling job by local and state agencies.

C. LEGAL OBSTACLES

For the PRT proposal, legislation may be required, probably on the local level, to sort out the question of jurisdiction. Legislation on the State level is certainly needed for retrofit, gaseous conversion, and the "bounty" on older cars or the exclusion from the CBD.

Present legislation providing fuel tax relief for gaseous conversion must be extended beyond 1975. Similar legislation must be developed and enacted for retrofit. If an inspection program is included, this too must be enacted. It should be noted that Washington does not have a vehicle inspection law, and does not meet Federal traffic safety standards in this area.

The "bounty" program to discourage ownership of older autos would certainly face serious legislative obstacles because of funding requirements. Increases in fuel and user taxes and fees, or new taxes on new vehicles would be obviously unpopular.

D. POLITICAL AND SOCIAL OBSTACLES

It is in this area that improvements to downtown signals may encounter problems. It is anticipated that such a program would receive mixed reaction, ranging from enthusiasm for improved access to disapproval of any action enhancing the automobile's position in downtown access and circulation.

The exclusion of older vehicles from the CBD is likely to face strong political opposition because of its discriminatory nature.

E. ECONOMIC OBSTACLES

The PRT idea will certainly involve high costs. Funding assistance is available through Federal Department of Transportation programs, and revenue sharing may help. Nevertheless, funding such a project is a major obstacle to be overcome. It should be kept in mind, however, that this project is intended to achieve goals other than air quality improvement.

Signal improvements are, of course, much less costly. Still, City budgets are tight, and signal improvements in other areas have call on available monies. The Federal TOPICS program can assist.

The retrofit program has the advantage of low unit cost (about $40 per vehicle for the "air bleed to intake manifold" device), but gaseous conversion is up to ten times that in unit cost. Also as mentioned before, funding a "bounty" program for older cars could involve large sums - perhaps millions of dollars. This is a definite obstacle from an economic and political standpoint.

F. TECHNICAL OBSTACLES

PRT's are being studied widely and a working demonstration exists in Morgantown. Nevertheless, the technology must be classified as "emerging," and care should be exercised in selecting designs for application. For the PRT, time is an obstacle. Preliminary planning, detailed planning, hearings and applications, design, construction, and testing must be accomplished. Many sidetracks and detours could occur before 1977.

It has been mentioned that the downtown signal plans are experimental in nature. Definitive application must await this testing phase.

Technical obstacles to gaseous conversion are documented; and include fuel handling, maintenance problems for pre-1971 engines and the shortage of natural gas if that alternative is selected.

The "bounty" strategy creates a whole range of technical obstacles, but ones more related to scale than to methodology. Disposal problems must be solved.

VI. SURVEILLANCE REVIEW PROCESS

Surveillance review involves several overall steps. Initially, an air quality implementation plan must be adopted and promulgated. Then, specific elements within that plan must be implemented. Finally, the impact of each element must be monitored continually in terms of legislative and administrative actions, physical implementation, and air quality improvement.

Table VI-1 lists various milestones for each Group 1 and Group 2 strategy evaluated, assuming that all are initiated by the first of the year 1973. Of course it is far from sure that each strategy will find its way into an adopted implementation plan. Also the initiation of some strategies may be delayed for various reasons, and others may have different schedules after detailed design. Therefore, Table VI-1 should be considered as a general source for more detailed scheduling.

The three curves in Figure VI-1 show the decrease in CO concentration expected from 1970 through 1979 at the Municipal Building as a result of:

- No strategies
- Strategies 1, 2, and 3 (METRO, PRT, Signal System)
- Strategies 1, 2, and 3 plus the exclusion of pre-controlled vehicles from the CBD.

These curves can be used as guides to the success of the emission control program. However, because of year-to-year variations in meteorological and other controlling factors, actual observations are expected to show considerable scatter about the predicted curves.

TABLE VI-1

SURVEILLANCE REVIEW PROCESS

STRATEGY	1973	1974	1975	1976	1977
Support METRO transit development	Monitor progress: a) Acquisition of properties b) Commencement of operations (early in year) Monitor status and progress of detailed planning for park-ride facilities	Check status of planning and commencement of design. Monitor progress of hearings, approvals, and grant applications. Monitor progress of contract award and beginning of construction.	Monitor Construction progress. Monitor opening of park-ride lots and diversion of auto users.		
Develop fringe parking and PRT	Check status and progress of route location study. Monitor status of permanent improvements.	Monitor start of design and design progress. Monitor progress of hearings, and grant applications.	Check on construction contract award and monitor progress.	Monitor construction progress.	Monitor construction progress and beginning of operation.
Improve downtown signals	Check results of SICOP test. Monitor status of permanent improvements.				
Retrofit heavy duty fleet vehicles	Check progress: a) Development of legislation. b) Enactment c) Development of administrative regulations. d) Development of implementation programs.	Monitor implementation progress.	Monitor implementation progress.	Monitor implementation progress.	Monitor implementation progress.
Exclusion of pre-controlled vehicles	Check progress: a) Development of legislation. b) Enactment c) Development of administrative regulations.	Monitor enforcement procedures.	Monitor enforcement procedures.	Monitor enforcement procedures.	Monitor enforcement procedures.
Encourage gaseous conversion of fleets	Monitor success of conversion program. Check progress of promotion program.	Monitor success of conversion program. Check progress of promotion program.	Check progress: a) Development of legislation extending incentive program. b) Enactment Monitor success of conversion program and promotional activities.	Monitor program.	Monitor program.
Program to discourage ownership of older, pre-controlled vehicles.	Check progress: a) Development of legislation b) Enactment c) Development of administrative regulations. d) Development of implementation programs.	Monitor implementation progress.	Monitor implementation progress.	Monitor implementation progress.	Monitor implementation progress.

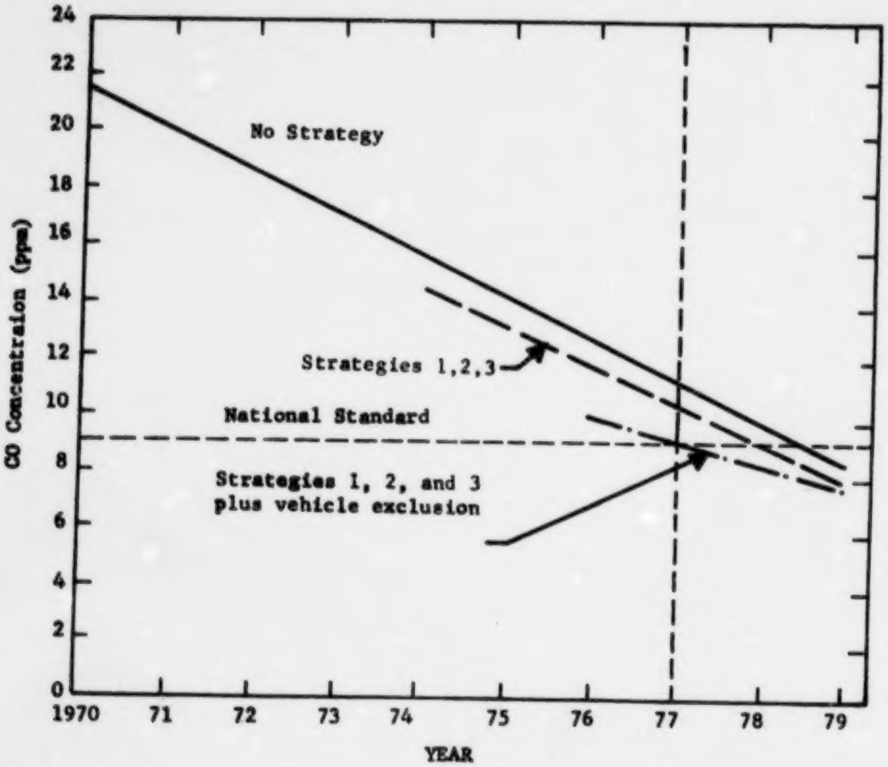

Figure VI-1. Projected 8-hour CO concentration in Seattle CBD based on 1971 data.

APPENDIX A

VEHICLE MILES OF TRAVEL (VMT)

The data contained in the following tables were provided as input to the emissions model. Total district VMT was estimated by facility type as described in Section II C of the text. VMT by vehicle type was factored, as described in the text. It should be noted that the estimates for heavy duty vehicles (trucks) and diesel vehicles (non-gasoline) are based on regional and area factors, as real data for this level of detail is not available. These figures provide the best estimates of regional travel prorated to a district level for purposes of analysis.

In the tables which follow, roadway types have been classified in standard terminology as follows:

Freeway:	A high-standard, grade-separated highway with complete control of access.
Arterial:	A surface street or highway with limited or no access control and traffic signals at major intersections.
Collector:	A surface street that feeds traffic to arterials.
Local:	A surface street that provides access to adjacent land.

Vehicle Miles of Travel (VMT)

Metropolitan Area Seattle
Year 1971
Time Period Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
1	Freeway	50	6,242	640	147	
	Arterial	20	2,573	264	61	
	Collector		--	--	--	
	Local	15	272	28	6	
	TOTAL		9,087	932	214	1
2	Freeway	50	7,193	737	170	
	Arterial	20-25	4,434	454	105	
	Collector		--	--	--	
	Local	15	300	31	7	
	TOTAL		11,927	1,222	282	1
3	Freeway		0	0	0	
	Arterial	20-25	4,083	418	97	
	Collector		--	--	--	
	Local	15	515	53	12	
	TOTAL		4,598	471	109	1
4	Freeway	40	9,146	937	217	
	Arterial	18-25	3,641	373	86	
	Collector		--	--	--	
	Local	15	360	37	8	
	TOTAL		13,147	1,347	311	1
6	Freeway	50	9,324	956	220	
	Arterial	20-25	1,954	200	46	
	Collector		--	--	--	
	Local	15	588	60	14	
	TOTAL		11,866	1,216	280	1
7	Freeway		0	0	0	
	Arterial	20-25	4,848	497	115	
	Collector		--	--	--	
	Local	15	567	58	14	
	TOTAL		5,415	555	129	1

Seattle - 1971 - Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
8	Freeway	50	10,390	1,065	245	
	Arterial	20-35	5,328	546	126	
	Collector		--	--	--	
	Local	15	643	66	15	
	TOTAL		16,361	1,677	386	1
9	Freeway		0	0	0	
	Arterial	20-35	5,035	516	119	
	Collector		--	--	--	
	Local	15	540	55	13	
	TOTAL		5,575	571	132	1
10	Freeway	50	10,300	1,056	244	
	Arterial	20-25	5,506	564	130	
	Collector		--	--	--	
	Local	15	823	84	20	
	TOTAL		16,629	1,704	394	1
11	Freeway		0	0	0	
	Arterial	20-35	7,330	751	174	
	Collector		--	--	--	
	Local	15	551	57	13	
	TOTAL		7,881	808	187	1
12	Freeway	50	11,544	1,183	273	
	Arterial	20-25	6,038	619	143	
	Collector		--	--	--	
	Local	15	535	55	13	
	TOTAL		18,117	1,857	429	1
13	Freeway		0	0	0	
	Arterial	15-20	4,843	496	115	
	Collector		--	--	--	
	Local	15	252	26	6	
	TOTAL		5,095	522	121	1
14	Freeway		0	0	0	
	Arterial	20-35	6,478	664	153	
	Collector		--	--	--	
	Local	15	403	41	10	
	TOTAL		6,881	705	163	1

Seattle - 1971 - Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
15	Freeway	50	13,320	1,365	315	
	Arterial	20-25	2,753	282	65	
	Collector		--	--	--	
	Local	15	527	54	13	
	TOTAL		16,600	1,701	393	1
16	Freeway	40	3,132	321	75	
	Arterial	20	3,183	326	75	
	Collector		--	--	--	
	Local	15	432	44	10	
	TOTAL		6,747	691	160	1
17	Freeway		0	0	0	
	Arterial	20-25	6,482	664	153	
	Collector		--	--	--	
	Local	15	344	35	8	
	TOTAL		6,826	699	161	1
18	Freeway		0	0	0	
	Arterial	18-35	12,352	1,266	292	
	Collector		--	--	--	
	Local	15	400	41	9	
	TOTAL		12,752	1,307	301	1
19	Freeway	45	12,610	1,292	298	
	Arterial	20	5,328	546	126	
	Collector		--	--	--	
	Local	15	643	66	15	
	TOTAL		18,581	1,904	439	1
20	Freeway		0	0	0	
	Arterial	20	3,125	320	74	
	Collector		--	--	--	
	Local	15	751	77	18	
	TOTAL		3,876	397	92	1
21	Freeway	40	11,633	1,192	275	
	Arterial	12-25	19,270	1,975	455	
	Collector		--	--	--	
	Local	15	136	14	3	
	TOTAL		31,039	3,181	733	1

Seattle - 1971 - Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
22	Freeway		0	0	0	
	Arterial	20	6,633	680	157	
	Collector		--	--	--	
	Local	15	684	70	16	
	TOTAL		7,317	750	173	1
23	Freeway	45	7,903	810	187	
	Arterial	18-20	9,235	946	219	
	Collector		--	--	--	
	Local	15	339	35	8	
	TOTAL		17,477	1,791	414	1
24	Freeway		0	0	0	
	Arterial	15-25	7,680	787	182	
	Collector		--	--	--	
	Local	15	959	98	23	
	TOTAL		8,639	885	205	1
25	Freeway		0	0	0	
	Arterial	20-40	6,305	646	149	
	Collector		--	--	--	
	Local	15	120	12	3	
	TOTAL		6,425	658	152	1
26	Freeway	40	7,548	773	179	
	Arterial	20	4,884	501	115	
	Collector		--	--	--	
	Local	15	232	24	5	
	TOTAL		12,664	1,298	299	1
27	Freeway		0	0	0	
	Arterial	20-35	7,648	784	181	
	Collector		--	--	--	
	Local	15	268	27	7	
	TOTAL		7,916	811	188	1
28	Freeway		0	0	0	
	Arterial	20-40	9,413	965	222	
	Collector		--	--	--	
	Local	15	40	4	1	
	TOTAL		9,453	969	223	

Seattle - 1971 - Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
29	Freeway	40	7, 548	774	178	
	Arterial	20-40	7, 193	737	170	
	Collector		--	--	--	
	Local	15	364	37	9	
	TOTAL		15, 105	1, 548	357	1
30	Freeway	50	6, 721	689	159	
	Arterial	20-25	4, 372	448	103	
	Collector		--	--	--	
	Local	15	403	41	10	
	TOTAL		11, 496	1, 178	272	1
31	Freeway		0	0	0	
	Arterial	20-35	5, 403	554	127	
	Collector		--	--	--	
	Local	15	236	24	6	
	TOTAL		5, 639	578	133	1
32	Freeway	50	4, 020	412	95	
	Arterial	20	3, 205	328	76	
	Collector		--	--	--	
	Local	15	195	20	5	
	TOTAL		7, 420	760	176	1
33	Freeway	40-50	9, 387	962	222	
	Arterial	35	703	72	17	
	Collector		--	--	--	
	Local	15	284	29	7	
	TOTAL		10, 374	1, 063	246	1
34	Freeway	40	4, 618	473	109	
	Arterial	20-25	1, 154	118	28	
	Collector		--	--	--	
	Local	15	144	15	3	
	TOTAL		5, 916	606	140	1
35	Freeway	45-50	5, 550	569	131	
	Arterial	20-35	2, 939	301	70	
	Collector		--	--	--	
	Local	15	220	24	4	
	TOTAL		8, 709	894	205	1

Seattle - 1971 - Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
36	Freeway	45	3,374	346	80	
	Arterial	20	6,926	710	164	
	Collector		--	--	--	
	Local	15	339	35	8	
	TOTAL		10,639	1,091	252	1
37	Freeway	40	3,019	309	72	
	Arterial	20-25	3,108	319	73	
	Collector		--	--	--	
	Local	15	272	28	6	
	TOTAL		6,399	656	151	1
38	Freeway	40	2,753	282	65	
	Arterial	25	799	82	19	
	Collector		--	--	--	
	Local	15	272	28	6	
	TOTAL		3,824	392	90	1
39	Freeway	55	3,907	400	93	
	Arterial	25	977	100	23	
	Collector		--	--	--	
	Local	15	256	26	6	
	TOTAL		5,140	526	122	1
40	Freeway	50	2,753	282	65	
	Arterial	19-25	6,838	701	161	
	Collector		--	--	--	
	Local	15	220	23	5	
	TOTAL		9,811	1,006	231	1
41	Freeway	50	6,127	628	145	
	Arterial	30	799	82	19	
	Collector		--	--	--	
	Local	15	179	18	5	
	TOTAL		7,105	728	169	1
42	Freeway		0	0	0	
	Arterial	20	10,390	1,065	245	
	Collector		--	--	--	
	Local	15	240	25	5	
	TOTAL		10,630	1,090	250	1

Seattle - 1971 - Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
43	Freeway		0	0	0	
	Arterial	20-25	8,347	855	198	
	Collector		--	--	--	
	Local	15	184	19	4	
	TOTAL		8,531	874	202	1
44	Freeway		0	0	0	
	Arterial	20	5,091	522	120	
	Collector		--	--	--	
	Local	15	160	16	4	
	TOTAL		5,251	538	124	1
45	Freeway	55	4,547	466	108	
	Arterial	20-25	4,667	478	111	
	Collector		--	--	--	
	Local	15	444	46	10	
	TOTAL		9,658	990	229	1
46	Freeway	50	5,328	546	126	
	Arterial	20-35	7,104	728	168	
	Collector		--	--	--	
	Local	15	355	36	9	
	TOTAL		12,787	1,310	303	1
47	Freeway	50	4,795	491	114	
	Arterial	20-25	1,687	173	40	
	Collector		--	--	--	
	Local	15	533	55	12	
	TOTAL		7,015	719	166	1
48	Freeway	50	3,374	346	80	
	Arterial	20	3,197	328	75	
	Collector		--	--	--	
	Local	15	599	61	15	
	TOTAL		7,170	735	170	1
	Freeway		TOTAL	TOTAL	TOTAL	VMT Total For All Vehicle Types
	Arterial					
	Collector					
	Local					
	TOTAL		467,510	47,911	11,058	526,479

Vehicle Miles of Travel (VMT)

Metropolitan Area Seattle
Year 1971
Time Period 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
1	Freeway	60	51, 479	5, 278	1, 213	
	Arterial	25	21, 220	2, 177	503	
	Collector		-	-	-	
	Local	15	2, 243	231	50	
	TOTAL		74, 942	7, 686	1, 766	1
2	Freeway	60	59, 323	6, 078	1, 402	
	Arterial	25	36, 568	3, 744	866	
	Collector		-	-	-	
	Local	15	2, 474	256	58	
	TOTAL		98, 365	10, 078	2, 326	1
3	Freeway		0	0	0	
	Arterial	20-30	33, 673	3, 447	800	
	Collector		-	-	-	
	Local	15	4, 248	437	99	
	TOTAL		37, 921	3, 884	899	1
4	Freeway	60	75, 430	7, 727	1, 790	
	Arterial	20-25	30, 028	3, 076	710	
	Collector		-	-	-	
	Local	15	2, 969	305	66	
	TOTAL		108, 427	11, 109	2, 566	1
6	Freeway	60	76, 898	7, 885	1, 814	
	Arterial	25	16, 115	1, 649	379	
	Collector		-	-	-	
	Local	15	4, 850	495	115	
	TOTAL		97, 863	10, 029	2, 309	1
7	Freeway		0	0	0	
	Arterial	20-30	39, 983	4, 099	949	
	Collector		-	-	-	
	Local	15	4, 676	478	115	
	TOTAL		44, 659	4, 577	1, 064	1

Seattle - 1971 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
8	Freeway	60	85,689	8,784	2,021	
	Arterial	20-35	43,942	4,503	1,039	
	Collector		-	-	-	
	Local	15	5,303	545	124	
	TOTAL		134,934	13,832	3,184	1
9	Freeway		0	0	0	
	Arterial	20-35	41,526	4,255	981	
	Collector		-	-	-	
	Local	15	4,454	454	107	
	TOTAL		45,980	4,709	1,088	1
10	Freeway	55	84,947	8,709	2,012	
	Arterial	20-25	45,410	4,651	1,072	
	Collector		-	-	-	
	Local	15	6,787	693	165	
	TOTAL		137,144	14,053	3,249	1
11	Freeway		0	0	0	
	Arterial	20-35	60,453	6,194	1,435	
	Collector		-	-	-	
	Local	15	4,544	470	107	
	TOTAL		64,997	6,664	1,542	1
12	Freeway	55	95,207	9,756	2,251	
	Arterial	20-25	49,797	5,105	1,179	
	Collector		-	-	-	
	Local	15	4,413	374	107	
	TOTAL		149,417	15,315	3,537	
13	Freeway		0	0	0	
	Arterial	20-25	39,941	4,091	949	
	Collector		-	-	-	
	Local	15	2,078	215	50	
	TOTAL		42,019	4,306	999	1
14	Freeway		0	0	0	
	Arterial	25-35	53,426	5,476	1,262	
	Collector		-	-	-	
	Local	15	3,323	338	82	
	TOTAL		56,749	5,814	1,344	1

Seattle - 1971 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
15	Freeway	55	109,854	11,258	2,598	
	Arterial	20-25	22,705	2,326	536	
	Collector		-	-	-	
	Local	15	4,346	445	107	
	TOTAL		136,905	14,029	3,241	1
16	Freeway	50	25,830	2,647	619	
	Arterial	25	26,251	2,689	619	
	Collector		-	-	-	
	Local	15	3,563	363	82	
	TOTAL		55,644	5,699	1,320	1
17	Freeway		0	0	0	
	Arterial	20-30	53,459	5,476	1,262	
	Collector		-	-	-	
	Local	15	2,837	289	66	
	TOTAL		56,296	5,765	1,328	1
18	Freeway		0	0	0	
	Arterial	20-35	101,871	10,441	2,408	
	Collector		-	-	-	
	Local	15	3,299	338	74	
	TOTAL		105,170	10,779	2,482	1
19	Freeway	50	103,998	10,655	2,458	
	Arterial	20	43,942	4,503	1,039	
	Collector		-	-	-	
	Local	15	5,303	545	124	
	TOTAL		153,243	15,703	3,621	1
20	Freeway		0	0	0	
	Arterial	25	25,773	2,639	610	
	Collector		-	-	-	
	Local	15	6,194	635	149	
	TOTAL		31,967	3,274	759	1
21	Freeway	50	95,941	9,831	2,268	
	Arterial	12-25	158,925	16,288	3,753	
	Collector		-	-	-	
	Local	15	1,122	115	25	
	TOTAL		255,988	26,234	6,046	1

Seattle - 1971 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
22	Freeway		0	0	0	
	Arterial	20-25	54, 704	5, 608	1, 295	
	Collector		-	-	-	
	Local	15	5, 641	577	132	
	TOTAL		60, 345	6, 185	1, 427	1
23	Freeway	50	65, 178	6, 680	1, 542	
	Arterial	20-25	76, 164	7, 802	1, 806	
	Collector		-	-	-	
	Local	15	2, 796	289	66	
	TOTAL		144, 138	14, 771	3, 414	1
24	Freeway		0	0	0	
	Arterial	20-35	63, 339	6, 491	1, 501	
	Collector		-	-	-	
	Local	15	7, 909	808	189	
	TOTAL		71, 248	7, 299	1, 690	1
25	Freeway		0	0	0	
	Arterial	25-50	52, 000	5, 328	1, 229	
	Collector		-	-	-	
	Local	15	990	99	25	
	TOTAL		52, 990	5, 427	1, 254	1
26	Freeway	60	62, 251	6, 375	1, 476	
	Arterial	25	40, 280	4, 132	949	
	Collector		-	-	-	
	Local	15	1, 913	198	42	
	TOTAL		104, 444	10, 705	2, 467	1
27	Freeway		0	0	0	
	Arterial	25-35	63, 075	6, 466	1, 493	
	Collector		-	-	-	
	Local	15	2, 210	223	58	
	TOTAL		65, 285	6, 689	1, 551	1
28	Freeway		0	0	0	
	Arterial	25-50	77, 632	7, 959	1, 831	
	Collector		-	-	-	
	Local	15	330	33	8	
	TOTAL		77, 962	7, 992	1, 839	1

Seattle - 1971 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
29	Freeway	50-55	62, 251	6, 383	1, 468	
	Arterial	25-35	59, 323	6, 078	1, 402	
	Collector		-	-	-	
	Local	15	3, 002	305	74	
	TOTAL		124, 576	12, 766	2, 944	1
30	Freeway	60	55, 430	5, 682	1, 311	
	Arterial	25	36, 057	3, 695	849	
	Collector		-	-	-	
	Local	15	3, 324	338	82	
	TOTAL		94, 811	9, 715	2, 242	1
31	Freeway		0	0	0	
	Arterial	25-35	44, 560	4, 569	1, 048	
	Collector		-	-	-	
	Local	15	1, 946	198	50	
	TOTAL		46, 506	4, 767	1, 098	1
32	Freeway	60	33, 154	3, 398	784	
	Arterial	25	26, 433	2, 705	627	
	Collector		-	-	-	
	Local	15	1, 608	165	42	
	TOTAL		61, 195	6, 268	1, 453	1
33	Freeway	55-60	77, 418	7, 934	1, 831	
	Arterial	35	5, 798	594	140	
	Collector		-	-	-	
	Local	15	2, 342	239	58	
	TOTAL		85, 558	8, 767	2, 029	1
34	Freeway	50	38, 086	3, 901	899	
	Arterial	25-35	9, 517	973	231	
	Collector		-	-	-	
	Local	15	1, 188	124	25	
	TOTAL		48, 791	4, 998	1, 155	1
35	Freeway	55	45, 773	4, 693	1, 080	
	Arterial	25-35	24, 239	2, 482	577	
	Collector		-	-	-	
	Local	15	1, 814	198	33	
	TOTAL		71, 826	7, 373	1, 690	1

Seattle - 1971 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
36	Freeway	55	27, 826	2, 854	660	
	Arterial	25	57, 121	5, 855	1, 352	
	Collector		-	-	-	
	Local	15	2, 796	289	66	
	TOTAL		87, 743	8, 998	2, 078	1
37	Freeway	55	24, 899	2, 548	594	
	Arterial	25	25, 633	2, 631	602	
	Collector		-	-	-	
	Local	15	2, 243	231	49	
	TOTAL		52, 775	5, 410	1, 245	1
38	Freeway	55	22, 705	2, 326	536	
	Arterial	25	6, 590	676	157	
	Collector		-	-	-	
	Local	15	2, 243	231	50	
	TOTAL		31, 538	3, 233	743	1
39	Freeway	60	32, 222	3, 299	767	
	Arterial	30	8, 058	825	190	
	Collector		-	-	-	
	Local	15	2, 112	214	49	
	TOTAL		42, 392	4, 338	1, 006	1
40	Freeway	60	22, 705	2, 326	536	
	Arterial	20-25	56, 395	5, 781	1, 328	
	Collector		-	-	-	
	Local	15	1, 814	189	42	
	TOTAL		80, 914	8, 296	1, 906	
41	Freeway	55	50, 531	5, 179	1, 196	
	Arterial	30	6, 590	676	157	
	Collector		-	-	-	
	Local	15	1, 476	149	42	
	TOTAL		58, 597	6, 004	1, 395	1
42	Freeway		0	0	0	
	Arterial	20	85, 689	8, 784	2, 021	
	Collector		-	-	-	
	Local	15	1, 979	207	42	
	TOTAL		87, 668	8, 991	2, 063	1

Seattle - 1971 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
43	Freeway		0	0	0	
	Arterial	25-30	68, 840	7, 052	1, 633	
	Collector		-	-	-	
	Local	15	1, 517	157	33	
	TOTAL		70, 357	7, 209	1, 666	1
44	Freeway		0	0	0	
	Arterial	25	41, 987	4, 305	990	
	Collector		-	-	-	
	Local	15	1, 320	132	33	
	TOTAL		43, 307	4, 437	1, 023	1
45	Freeway	60	37, 501	3, 844	891	
	Arterial	25	38, 490	3, 942	915	
	Collector		-	-	-	
	Local	15	3, 662	380	82	
	TOTAL		79, 653	8, 166	1, 888	1
46	Freeway	60	43, 942	4, 503	1, 039	
	Arterial	25-35	58, 589	6, 004	1, 386	
	Collector		-	-	-	
	Local	15	2, 928	297	74	
	TOTAL		105, 459	10, 804	2, 499	1
47	Freeway	60	39, 546	4, 049	940	
	Arterial	25	13, 913	1, 427	330	
	Collector		-	-	-	
	Local	15	4, 396	454	99	
	TOTAL		57, 855	5, 930	1, 369	1
48	Freeway	60	27, 826	2, 854	660	
	Arterial	25	26, 367	2, 705	619	
	Collector		-	-	-	
	Local	15	4, 940	503	124	
	TOTAL		59, 133	6, 062	1, 403	1
	Freeway Arterial Collector Local		TOTAL	TOTAL	TOTAL	VMT Total For All Vehicle Types
	TOTAL		3, 855, 696	395. 139	91, 207	4, 342, 042

Vehicle Miles of Travel (VMT)

Metropolitan Area Seattle

Year 1971

Time Period 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
1	Freeway	60	69,286	7,104	1,632	
	Arterial	25	28,560	2,930	677	
	Collector		--	--	--	
	Local	15	3,019	311	67	
	TOTAL		100,865	10,345	2,376	1
2	Freeway	60	79,842	8,181	1,887	
	Arterial	25	49,217	5,039	1,166	
	Collector		--	--	--	
	Local	15	3,330	344	78	
	TOTAL		132,389	13,564	3,131	1
3	Freeway		0	0	0	
	Arterial	20-30	45,321	4,640	1,077	
	Collector		--	--	--	
	Local	15	5,717	588	133	
	TOTAL		51,038	5,228	1,210	1
4	Freeway	60	101,521	10,401	2,409	
	Arterial	20-25	40,415	4,140	955	
	Collector		--	--	--	
	Local	15	3,996	411	89	
	TOTAL		145,932	14,952	3,453	1
6	Freeway	60	103,496	10,612	2,442	
	Arterial	25	21,689	2,220	511	
	Collector		--	--	--	
	Local	15	6,527	666	155	
	TOTAL		131,712	13,498	3,108	1
7	Freeway		0	0	0	
	Arterial	20-30	53,813	5,517	1,277	
	Collector		--	--	--	
	Local	15	6,294	644	155	
	TOTAL		60,107	6,161	1,432	1

Seattle - 1971 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
8	Freeway	60	115,329	11,822	2,720	
	Arterial	20-35	59,141	6,061	1,399	
	Collector		--	--	--	
	Local	15	7,137	733	167	
	TOTAL		181,607	18,616	4,286	1
9	Freeway		0	0	0	
	Arterial	20-35	55,889	5,728	1,321	
	Collector		--	--	--	
	Local	15	5,994	611	144	
	TOTAL		61,883	6,339	1,465	1
10	Freeway	55	114,330	11,722	2,708	
	Arterial	20-25	61,117	6,260	1,443	
	Collector		--	--	--	
	Local	15	9,135	932	222	
	TOTAL		184,582	18,914	4,373	1
11	Freeway		0	0	0	
	Arterial	20-35	81,363	8,336	1,931	
	Collector		--	--	--	
	Local	15	6,116	633	144	
	TOTAL		87,479	8,969	2,075	1
12	Freeway	55	128,138	13,131	3,030	
	Arterial	20-25	67,022	6,871	1,587	
	Collector		--	--	--	
	Local	15	5,939	611	144	
	TOTAL		201,099	20,613	4,761	1
13	Freeway		0	0	0	
	Arterial	20-25	53,757	5,506	1,277	
	Collector		--	--	--	
	Local	15	2,797	289	67	
	TOTAL		56,554	5,795	1,344	1
14	Freeway		0	0	0	
	Arterial	25-35	71,906	7,370	1,698	
	Collector		--	--	--	
	Local	15	4,473	455	111	
	TOTAL		76,379	7,825	1,809	1

Seattle - 1971 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
15	Freeway	55	147,852	15,152	3,497	
	Arterial	20-25	30,558	3,130	722	
	Collector		--	--	--	
	Local	15	5,850	599	144	
	TOTAL		184,260	18,881	4,363	1
16	Freeway	50	34,765	3,563	833	
	Arterial	25	35,331	3,619	833	
	Collector		--	--	--	
	Local	15	4,795	488	111	
	TOTAL		74,891	7,670	1,777	1
17	Freeway		0	0	0	
	Arterial	25-30	71,950	7,370	1,698	
	Collector		--	--	--	
	Local	15	3,818	389	89	
	TOTAL		75,768	7,759	1,787	1
18	Freeway		0	0	0	
	Arterial	25-35	137,107	14,053	3,241	
	Collector		--	--	--	
	Local	15	4,440	455	100	
	TOTAL		141,547	14,508	3,341	1
19	Freeway	50	139,971	14,341	3,308	
	Arterial	20	59,141	6,061	1,399	
	Collector		--	--	--	
	Local	15	7,137	733	167	
	TOTAL		206,249	21,135	4,874	1
20	Freeway		0	0	0	
	Arterial	25	34,688	3,552	821	
	Collector		--	--	--	
	Local	15	8,336	855	200	
	TOTAL		43,024	4,407	1,021	1
21	Freeway	50	129,126	13,231	3,053	
	Arterial	12-25	213,897	21,923	5,051	
	Collector		--	--	--	
	Local	15	1,510	155	33	
	TOTAL		344,533	35,309	8,137	1

Seattle - 1971 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
22	Freeway		0	0	0	
	Arterial	20-25	73,626	7,548	1,743	
	Collector		--	--	--	
	Local	15	7,592	777	178	
	TOTAL		81,218	8,325	1,921	1
23	Freeway	50	87,723	8,991	2,076	
	Arterial	20-25	102,509	10,501	2,431	
	Collector		--	--	--	
	Local	15	3,763	389	89	
	TOTAL		193,995	19,881	4,596	1
24	Freeway		0	0	0	
	Arterial	20-35	85,248	8,736	2,020	
	Collector		--	--	--	
	Local	15	10,645	1,088	255	
	TOTAL		95,893	9,824	2,275	1
25	Freeway		0	0	0	
	Arterial	25-50	69,986	7,171	1,654	
	Collector		--	--	--	
	Local	15	1,332	133	33	
	TOTAL		71,318	7,304	1,687	1
26	Freeway	60	83,783	8,580	1,987	
	Arterial	25	54,212	5,561	1,277	
	Collector		--	--	--	
	Local	15	2,575	266	56	
	TOTAL		140,570	14,407	3,320	1
27	Freeway		0	0	0	
	Arterial	25-35	84,893	8,702	2,009	
	Collector		--	--	--	
	Local	15	2,975	300	78	
	TOTAL		87,868	9,002	2,087	1
28	Freeway		0	0	0	
	Arterial	25-50	104,484	10,712	2,464	
	Collector		--	--	--	
	Local	15	444	44	11	
	TOTAL		104,928	10,756	2,475	1

Seattle - 1971 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
29	Freeway	50-55	83,783	8,591	1,976	
	Arterial	25-35	79,842	8,181	1,887	
	Collector		--	--	--	
	Local	15	4,040	411	100	
	TOTAL		167,665	17,183	3,963	1
30	Freeway	60	74,603	7,648	1,765	
	Arterial	25	48,529	4,973	1,143	
	Collector		--	--	--	
	Local	15	4,473	455	111	
	TOTAL		127,605	13,076	3,019	1
31	Freeway		0	0	0	
	Arterial	25-35	59,973	6,149	1,410	
	Collector		--	--	--	
	Local	15	2,620	266	67	
	TOTAL		62,593	6,415	1,477	1
32	Freeway	60	44,622	4,573	1,055	
	Arterial	25	35,576	3,641	844	
	Collector		--	--	--	
	Local	15	2,165	222	56	
	TOTAL		82,363	8,436	1,955	1
33	Freeway	55-60	104,196	10,678	2,464	
	Arterial	35	7,803	799	189	
	Collector		--	--	--	
	Local	15	3,152	322	78	
	TOTAL		115,151	11,799	2,731	1
34	Freeway	50	51,260	5,250	1,210	
	Arterial	25-35	12,809	1,310	311	
	Collector		--	--	--	
	Local	15	1,598	167	33	
	TOTAL		65,667	6,727	1,554	1
35	Freeway	55	61,605	6,316	1,454	
	Arterial	25-35	32,623	3,341	777	
	Collector		--	--	--	
	Local	15	2,442	266	44	
	TOTAL		96,670	9,923	2,275	1

Seattle - 1971 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
36	Freeway	55	37,451	3,841	888	
	Arterial	25	76,879	7,881	1,820	
	Collector		--	--	--	
	Local	15	3,763	388	89	
	TOTAL		118,093	12,110	2,797	1
37	Freeway	55	33,511	3,430	799	
	Arterial	25	34,499	3,541	810	
	Collector		--	--	--	
	Local	15	3,019	311	67	
	TOTAL		71,029	7,282	1,676	1
38	Freeway	55	30,558	3,130	722	
	Arterial	25	8,869	910	211	
	Collector		--	--	--	
	Local	15	3,019	311	67	
	TOTAL		42,446	4,351	1,000	1
39	Freeway	60	43,368	4,440	1,032	
	Arterial	30	10,845	1,110	255	
	Collector		--	--	--	
	Local	15	2,842	289	67	
	TOTAL		57,055	5,839	1,354	1
40	Freeway	60	30,558	3,130	722	
	Arterial	20-25	75,902	7,781	1,787	
	Collector		--	--	--	
	Local	15	2,442	255	56	
	TOTAL		108,902	11,166	2,565	1
41	Freeway	55	68,010	6,971	1,610	
	Arterial	30	8,869	910	211	
	Collector		--	--	--	
	Local	15	1,987	200	56	
	TOTAL		78,866	8,081	1,877	1
42	Freeway		0	0	0	
	Arterial	20	115,329	11,822	2,720	
	Collector		--	--	--	
	Local	15	2,664	278	56	
	TOTAL		117,993	12,100	2,776	1

Seattle - 1971 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
43	Freeway		0	0	0	
	Arterial	25-30	92,652	9,491	2,198	
	Collector		--	--	--	
	Local	15	2,042	211	44	
	TOTAL		94,694	9,702	2,242	1
44	Freeway		0	0	0	
	Arterial	25	56,510	5,794	1,332	
	Collector		--	--	--	
	Local	15	1,776	178	44	
	TOTAL		58,286	5,972	1,376	1
45	Freeway	60	50,472	5,173	1,199	
	Arterial	25	51,804	5,306	1,232	
	Collector		--	--	--	
	Local	15	4,928	511	111	
	TOTAL		107,204	10,990	2,542	1
46	Freeway	60	59,141	6,061	1,399	
	Arterial	25-35	78,854	8,081	1,865	
	Collector		--	--	--	
	Local	15	3,941	400	100	
	TOTAL		141,936	14,542	3,364	1
47	Freeway	60	53,225	5,450	1,265	
	Arterial	25	18,726	1,920	444	
	Collector		--	--	--	
	Local	15	5,916	611	133	
	TOTAL		77,867	7,981	1,842	1
48	Freeway	60	37,451	3,841	888	
	Arterial	25	35,487	3,641	833	
	Collector		--	--	--	
	Local	15	6,649	677	167	
	TOTAL		79,587	8,159	1,888	1
	Freeway		TOTAL	TOTAL	TOTAL	VMT Total For All Vehicle Types
	Arterial					
	Collector					
	Local					
	TOTAL		5,189,360	531,821	122,757	5,843,938

Vehicle Miles of Travel (VMT)

Metropolitan Area Seattle

Year 1977

Time Period Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
1	Freeway	40	7,241	742	171	
	Arterial	20	3,357	344	79	
	Collector		-	-	-	
	Local	15	313	32	7	
	TOTAL		10,911	1,118	257	1
2	Freeway	40	8,344	855	197	
	Arterial	15-25	5,427	556	128	
	Collector		-	-	-	
	Local	15	333	34	8	
	TOTAL		14,104	1,445	333	1
3	Freeway		0	0	0	
	Arterial	20-25	4,933	506	117	
	Collector		-	-	-	
	Local	15	567	58	13	
	TOTAL		5,500	564	130	1
4	Freeway	35	10,541	1,080	249	
	Arterial	18-20	4,489	460	106	
	Collector		-	-	-	
	Local	15	403	41	10	
	TOTAL		15,433	1,581	365	1
6	Freeway	40	10,744	1,101	254	
	Arterial	20-25	2,445	251	58	
	Collector		-	-	-	
	Local	15	646	66	15	
	TOTAL		13,835	1,418	327	1
7	Freeway		0	0	0	
	Arterial	20-26	5,646	579	134	
	Collector		-	-	-	
	Local	15	613	63	14	
	TOTAL		6,259	642	148	1

Seattle - 1977 - Peak Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
8	Freeway	25-35	13,266	1,359	314	
	Arterial	20	4,868	499	115	
	Collector		-	-	-	
	Local	15	701	72	17	
	TOTAL		18,835	1,930	446	1
9	Freeway		0	0	0	
	Arterial	20-35	5,911	606	140	
	Collector		-	-	-	
	Local	15	583	60	14	
	TOTAL		6,494	666	154	1
10	Freeway	50	11,614	1,190	275	
	Arterial	15-25	6,107	626	144	
	Collector		-	-	-	
	Local	15	873	89	21	
	TOTAL		18,594	1,905	440	1
11	Freeway		0	0	0	
	Arterial	20-30	8,424	863	199	
	Collector		-	-	-	
	Local	15	590	60	14	
	TOTAL		9,014	923	213	1
12	Freeway	35	12,925	1,325	306	
	Arterial	15-25	8,749	897	207	
	Collector		-	-	-	
	Local	15	567	58	13	
	TOTAL		22,241	2,280	526	1
13	Freeway		0	0	0	
	Arterial	12-20	5,096	522	121	
	Collector		-	-	-	
	Local	15	265	27	6	
	TOTAL		5,361	549	127	1
14	Freeway		0	0	0	
	Arterial	20-30	6,871	704	162	
	Collector		-	-	-	
	Local	15	416	43	10	
	TOTAL		7,287	747	172	1

Seattle - 1977 - Peak Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
15	Freeway	35-40	14,812	1,518	350	
	Arterial	20-25	3,078	315	73	
	Collector		-	-	-	
	Local	15	554	57	13	
	TOTAL		18,444	1,890	436	1
16	Freeway	35	3,383	347	80	
	Arterial	15	3,315	340	78	
	Collector		-	-	-	
	Local	15	445	46	11	
	TOTAL		7,143	733	169	1
17	Freeway		0	0	0	
	Arterial	20-25	6,926	710	164	
	Collector		-	-	-	
	Local	15	344	35	8	
	TOTAL		7,270	745	172	1
18	Freeway		0	0	0	
	Arterial	18-30	12,726	1,304	301	
	Collector		-	-	-	
	Local	15	404	41	10	
	TOTAL		13,130	1,345	311	1
19	Freeway	35	13,205	1,353	312	
	Arterial	20	5,369	550	127	
	Collector		-	-	-	
	Local	15	655	67	15	
	TOTAL		19,229	1,970	454	1
20	Freeway		0	0	0	
	Arterial	20	3,343	343	79	
	Collector		-	-	-	
	Local	15	804	82	19	
	TOTAL		4,147	425	98	1
21	Freeway	35-40	12,301	1,261	291	
	Arterial	12-25	23,291	2,387	551	
	Collector		-	-	-	
	Local	15	136	14	3	
	TOTAL		35,728	3,662	845	1

Seattle - 1977 - Peak Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
22	Freeway		0	0	0	
	Arterial	20	6,677	684	158	
	Collector		-	-	-	
	Local	15	684	70	6	
	TOTAL		7,361	754	174	1
23	Freeway	35-40	8,658	887	205	
	Arterial	18-25	9,182	941	217	
	Collector		-	-	-	
	Local	15	346	35	8	
	TOTAL		18,186	1,863	430	1
24	Freeway		0	0	0	
	Arterial	15-25	7,848	804	186	
	Collector		-	-	-	
	Local	15	959	98	23	
	TOTAL		8,807	902	209	1
25	Freeway		0	0	0	
	Arterial	20-40	6,305	646	149	
	Collector		-	-	-	
	Local	15	120	12	3	
	TOTAL		6,425	658	152	1
26	Freeway	50	8,543	876	202	
	Arterial	20	4,887	501	116	
	Collector		-	-	-	
	Local	15	231	24	5	
	TOTAL		13,661	1,401	323	1
27	Freeway		0	0	0	
	Arterial	20-35	7,784	798	184	
	Collector		-	-	-	
	Local	15	268	27	6	
	TOTAL		8,052	825	190	1
28	Freeway		0	0	0	
	Arterial	20-40	9,653	989	228	
	Collector		-	-	-	
	Local	15	40	4	1	
	TOTAL		9,693	993	229	1

Seattle - 1977 - Peak Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
29	Freeway	35-40	10,393	1,065	246	
	Arterial	20-35	5,347	548	126	
	Collector		-	-	-	
	Local	15	364	37	9	
	TOTAL		16,104	1,650	381	1
30	Freeway	50	7,528	771	178	
	Arterial	20-25	4,372	448	103	
	Collector		-	-	-	
	Local	15	403	41	10	
	TOTAL		12,303	1,260	291	1
31	Freeway		0	0	0	
	Arterial	20-35	5,773	592	137	
	Collector		-	-	-	
	Local	15	236	24	6	
	TOTAL		6,009	616	143	1
32	Freeway	40	4,502	461	106	
	Arterial	20	3,205	328	76	
	Collector		-	-	-	
	Local	15	195	20	5	
	TOTAL		7,902	809	187	1
33	Freeway	35-45	10,430	1,069	247	
	Arterial	35	915	94	22	
	Collector		-	-	-	
	Local	15	313	32	7	
	TOTAL		11,658	1,195	276	1
34	Freeway	35	5,475	561	129	
	Arterial	20-25	1,191	122	28	
	Collector		-	-	-	
	Local	15	144	15	3	
	TOTAL		6,810	698	160	
35	Freeway	35-40	6,337	649	150	
	Arterial	20-35	3,162	324	75	
	Collector		-	-	-	
	Local	15	220	23	5	
	TOTAL		9,719	996	230	1

Seattle - 1977 - Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
36	Freeway	45	3,712	380	88	
	Arterial	20	6,926	710	164	
	Collector		-	-	-	
	Local	15	339	35	8	
	TOTAL		10,977	1,125	260	1
37	Freeway	40	3,351	343	79	
	Arterial	20-25	3,347	343	79	
	Collector		-	-	-	
	Local	15	285	29	7	
	TOTAL		6,983	715	165	1
38	Freeway	35	3,221	330	76	
	Arterial	25	799	82	19	
	Collector		-	-	-	
	Local	15	272	28	6	
	TOTAL		4,292	440	101	1
39	Freeway	55	4,534	465	107	
	Arterial	25	1,255	129	30	
	Collector		-	-	-	
	Local	15	307	31	7	
	TOTAL		6,096	625	144	1
40	Freeway	50	3,028	310	72	
	Arterial	19-25	8,511	872	201	
	Collector		-	-	-	
	Local	15	256	26	6	
	TOTAL		11,795	1,208	279	1
41	Freeway	50	7,201	738	170	
	Arterial	30	968	99	23	
	Collector		-	-	-	
	Local	15	251	26	6	
	TOTAL		8,420	863	199	1
42	Freeway		0	0	0	
	Arterial	20-45	10,770	1,104	255	
	Collector		-	-	-	
	Local	15	249	25	6	
	TOTAL		11,019	1,129	261	1

Seattle - 1977 - Peak-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
43	Freeway		0	0	0	
	Arterial	20-25	9,182	941	217	
	Collector		-	-	-	
	Local	15	202	21	5	
	TOTAL		9,384	962	222	1
44	Freeway		0	0	0	
	Arterial	20	5,871	602	139	
	Collector		-	-	-	
	Local	15	168	17	4	
	TOTAL		6,039	619	143	1
45	Freeway	55	5,047	517	119	
	Arterial	20-25	4,901	502	116	
	Collector		-	-	-	
	Local	15	466	48	11	
	TOTAL		10,414	1,067	246	1
46	Freeway	50	5,914	606	140	
	Arterial	20-35	7,459	764	176	
	Collector		-	-	-	
	Local	15	373	38	9	
	TOTAL		13,746	1,408	325	1
47	Freeway	50	5,131	526	121	
	Arterial	20-25	1,780	182	42	
	Collector		-	-	-	
	Local	15	559	57	13	
	TOTAL		7,470	765	176	1
48	Freeway	50	5,079	521	120	
	Arterial	20	3,620	371	86	
	Collector		-	-	-	
	Local	15	660	68	16	
	TOTAL		9,359	960	222	1
	Freeway Arterial Collector Local		TOTAL	TOTAL	TOTAL	VMT Total For All Vehicle Types
	TOTAL		517,643	53,044	12,241	582,928

Vehicle Miles of Travel (VMT)

Metropolitan Area Seattle

Year 1977

Time Period 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
1	Freeway	55	59,719	6,119	1,410	
	Arterial	25	27,686	2,837	652	
	Collector		--	--	--	
	Local	15	2,581	264	58	
	TOTAL		89,986	9,220	2,120	1
2	Freeway	55	68,815	7,052	1,625	
	Arterial	25	44,758	4,586	1,056	
	Collector		--	--	--	
	Local	15	2,746	280	66	
	TOTAL		116,319	11,918	2,747	1
3	Freeway		0	0	0	
	Arterial	20-30	40,684	4,173	965	
	Collector		--	--	--	
	Local	15	4,676	478	107	
	TOTAL		45,360	4,651	1,072	1
4	Freeway	55	86,935	8,907	2,054	
	Arterial	20-25	37,022	3,794	874	
	Collector		--	--	--	
	Local	15	3,323	338	82	
	TOTAL		127,280	13,039	3,010	1
6	Freeway	55	88,609	9,080	2,095	
	Arterial	25	20,165	2,070	478	
	Collector		--	--	--	
	Local	15	5,328	545	124	
	TOTAL		114,102	11,695	2,697	1
7	Freeway		0	0	0	
	Arterial	20-30	46,565	4,775	1,105	
	Collector		--	--	--	
	Local	15	5,055	520	115	
	TOTAL		51,620	5,295	1,220	1

Seattle - 1977 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
8	Freeway	35-55	109,409	11,208	2,589	
	Arterial	20-25	40,148	4,115	949	
	Collector		--	--	--	
	Local	15	5,781	594	140	
	TOTAL		155,338	15,917	3,678	
9	Freeway		0	0	0	
	Arterial	25-35	48,750	4,998	1,155	
	Collector		--	--	--	
	Local	15	4,808	495	115	
	TOTAL		53,558	5,493	1,270	1
10	Freeway	55	95,784	9,814	2,268	
	Arterial	20-25	50,366	5,163	1,188	
	Collector		--	--	--	
	Local	15	7,200	734	173	
	TOTAL		153,350	15,711	3,629	1
11	Freeway		0	0	0	
	Arterial	20-35	69,475	7,117	1,641	
	Collector		--	--	--	
	Local	15	4,866	495	115	
	TOTAL		74,341	7,612	1,756	1
12	Freeway	50	106,597	10,928	2,524	
	Arterial	20-25	72,156	7,398	1,707	
	Collector		--	--	--	
	Local	15	4,676	478	107	
	TOTAL		183,429	18,804	4,338	1
13	Freeway		0	0	0	
	Arterial	20-25	42,029	4,305	998	
	Collector		--	--	--	
	Local	15	2,186	223	50	
	TOTAL		44,215	4,528	1,048	1
14	Freeway		0	0	0	
	Arterial	25-35	56,667	5,806	1,336	
	Collector		--	--	--	
	Local	15	3,431	354	82	
	TOTAL		60,098	6,160	1,418	1

Seattle - 1977 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
15	Freeway	50	122,159	12,520	2,887	
	Arterial	20-25	25,385	2,598	602	
	Collector		--	--	--	
	Local	15	4,569	470	107	
	TOTAL		152,113	15,588	3,596	1
16	Freeway	50	27,900	2,862	660	
	Arterial	25	27,340	2,804	643	
	Collector		--	--	--	
	Local	15	3,670	380	91	
	TOTAL		58,910	6,046	1,394	1
17	Freeway		0	0	0	
	Arterial	25-30	57,121	5,856	1,352	
	Collector		--	--	--	
	Local	15	2,837	289	66	
	TOTAL		59,958	6,145	1,418	1
18	Freeway		0	0	0	
	Arterial	25-35	104,955	10,754	2,482	
	Collector		--	--	--	
	Local	15	3,332	338	82	
	TOTAL		108,287	11,092	2,564	
19	Freeway	50	108,906	11,158	2,573	
	Arterial	20	44,280	4,536	1,048	
	Collector		--	--	--	
	Local	15	5,402	553	124	
	TOTAL		158,588	16,247	3,745	1
20	Freeway		0	0	0	
	Arterial	25	27,571	2,829	652	
	Collector		--	--	--	
	Local	15	6,631	676	157	
	TOTAL		34,202	3,505	809	1
21	Freeway	50	101,450	10,400	2,400	
	Arterial	12-25	192,088	19,687	4,544	
	Collector		--	--	--	
	Local	15	1,122	115	25	
	TOTAL		294,660	30,202	6,969	

Seattle - 1977 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
22	Freeway		0	0	0	
	Arterial	20-25	55,067	5,641	1,303	
	Collector		--	--	--	
	Local	15	5,641	577	132	
	TOTAL		60,708	6,218	1,435	1
23	Freeway	50	71,405	7,316	1,691	
	Arterial	20-25	75,727	7,761	1,790	
	Collector		--	--	--	
	Local	15	2,854	289	66	
	TOTAL		149,986	15,366	3,547	1
24	Freeway		0	0	0	
	Arterial	20-40	64,725	6,631	1,534	
	Collector		--	--	--	
	Local	15	7,909	808	190	
	TOTAL		72,634	7,439	1,724	1
25	Freeway		0	0	0	
	Arterial	25-50	52,000	5,328	1,229	
	Collector		--	--	--	
	Local	15	990	99	25	
	TOTAL		52,990	5,427	1,254	1
26	Freeway	60	70,456	7,225	1,666	
	Arterial	25	40,305	4,132	957	
	Collector		--	--	--	
	Local	15	1,905	198	41	
	TOTAL		112,666	11,555	2,664	1
27	Freeway		0	0	0	
	Arterial	25-35	64,197	6,581	1,517	
	Collector		--	--	--	
	Local	15	2,210	223	50	
	TOTAL		66,407	6,804	1,567	1
28	Freeway		0	0	0	
	Arterial	25-50	79,611	8,157	1,881	
	Collector		--	--	--	
	Local	15	330	33	8	
	TOTAL		79,941	8,190	1,889	1

Seattle - 1977 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
29	Freeway	50	85,714	8,784	2,029	
	Arterial	25-35	44,099	4,520	1,039	
	Collector		--	--	--	
	Local	15	3,002	305	74	
	TOTAL		132,815	13,609	3,142	1
30	Freeway	55	62,086	6,359	1,468	
	Arterial	25	36,057	3,695	849	
	Collector		--	--	--	
	Local	15	3,323	338	82	
	TOTAL		101,466	10,392	2,399	1
31	Freeway		0	0	0	
	Arterial	25-35	47,611	4,882	1,130	
	Collector		--	--	--	
	Local	15	1,947	198	50	
	TOTAL		49,558	5,080	1,180	1
32	Freeway	55	37,129	3,802	874	
	Arterial	25	26,433	2,705	627	
	Collector		--	--	--	
	Local	15	1,609	165	41	
	TOTAL		65,171	6,672	1,542	1
33	Freeway	55-60	86,019	8,816	2,037	
	Arterial	35	7,547	775	181	
	Collector		--	--	--	
	Local	15	2,581	264	58	
	TOTAL		96,147	9,855	2,276	1
34	Freeway	50	45,154	4,627	1,064	
	Arterial	30	9,822	1,006	231	
	Collector		--	--	--	
	Local	15	1,188	124	25	
	TOTAL		56,164	5,757	1,320	1
35	Freeway	55	52,263	5,353	1,237	
	Arterial	25-35	26,078	2,672	619	
	Collector		--	--	--	
	Local	15	1,814	190	42	
	TOTAL		80,155	8,215	1,898	1

Seattle - 1977 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
36	Freeway	55	30,614	3,134	726	
	Arterial	25	57,121	5,856	1,352	
	Collector		--	--	--	
	Local	15	2,796	289	66	
	TOTAL		90,531	9,279	2,144	1
37	Freeway	55	27,637	2,829	652	
	Arterial	25	27,604	2,829	652	
	Collector		--	--	--	
	Local	15	2,351	239	58	
	TOTAL		57,592	5,897	1,362	1
38	Freeway	55	26,564	2,722	627	
	Arterial	25	6,590	676	157	
	Collector		--	--	--	
	Local	15	2,243	231	50	
	TOTAL		35,397	3,629	834	1
39	Freeway	60	37,393	3,835	883	
	Arterial	30	10,351	1,064	247	
	Collector		--	--	--	
	Local	15	2,532	256	58	
	TOTAL		50,276	5,155	1,188	1
40	Freeway	60	24,973	2,557	594	
	Arterial	20-25	70,193	7,191	1,658	
	Collector		--	--	--	
	Local	15	2,112	215	50	
	TOTAL		97,278	9,963	2,302	1
41	Freeway	55	59,389	6,087	1,402	
	Arterial	30	7,984	817	189	
	Collector		--	--	--	
	Local	15	2,070	214	50	
	TOTAL		69,443	7,118	1,641	1
42	Freeway		0	0	0	
	Arterial	20-45	88,823	9,105	2,103	
	Collector		--	--	--	
	Local	15	2,054	206	50	
	TOTAL		90,877	9,311	2,153	1

Seattle - 1977 - 12-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
43	Freeway		0	0	0	
	Arterial	25-30	75,727	7,761	1,790	
	Collector		--	--	--	
	Local	15	1,666	173	41	
	TOTAL		77,393	7,934	1,831	1
44	Freeway		0	0	0	
	Arterial	25	48,420	4,965	1,146	
	Collector		--	--	--	
	Local	15	1,386	140	33	
	TOTAL		49,806	5,105	1,179	1
45	Freeway	60	41,624	4,264	981	
	Arterial	25	40,420	4,140	957	
	Collector		--	--	--	
	Local	15	3,844	396	91	
	TOTAL		85,888	8,800	2,029	1
46	Freeway	60	48,774	4,998	1,155	
	Arterial	25-35	61,517	6,301	1,452	
	Collector		--	--	--	
	Local	15	3,076	314	74	
	TOTAL		113,367	11,613	2,681	1
47	Freeway	60	42,317	4,338	998	
	Arterial	25	14,680	1,501	346	
	Collector		--	--	--	
	Local	15	4,610	470	107	
	TOTAL		61,607	6,309	1,451	1
48	Freeway	60	41,888	4,297	990	
	Arterial	25	29,855	3,060	710	
	Collector		--	--	--	
	Local	15	5,443	561	132	
	TOTAL		77,186	7,918	1,832	1
	Freeway Arterial Collector Local		TOTAL	TOTAL	TOTAL	VMT Total For All Vehicle Types
	TOTAL		4,269,163	437,478	100,962	4,807,603

Vehicle Miles of Travel (VMT)

Metropolitan Area Seattle
Year 1977
Time Period 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
1	Freeway	55	80,375	8,236	1,898	
	Arterial	25	37,263	3,818	877	
	Collector		-	-	-	
	Local	15	3,474	355	78	
	TOTAL		121,112	12,409	2,853	1
2	Freeway	55	92,618	9,491	2,187	
	Arterial	25	60,240	6,172	1,421	
	Collector		-	-	-	
	Local	15	3,696	377	89	
	TOTAL		156,554	16,040	3,697	1
3	Freeway		0	0	0	
	Arterial	20-30	54,756	5,617	1,299	
	Collector		-	-	-	
	Local	15	6,294	644	144	
	TOTAL		61,050	6,261	1,443	1
4	Freeway	55	117,005	11,988	2,764	
	Arterial	20-25	49,828	5,106	1,177	
	Collector		-	-	-	
	Local	15	4,473	455	111	
	TOTAL		171,306	17,549	4,052	1
6	Freeway	55	119,258	12,221	2,819	
	Arterial	25	27,140	2,786	644	
	Collector		-	-	-	
	Local	15	7,171	733	167	
	TOTAL		153,569	15,740	3,630	1
7	Freeway		0	0	0	
	Arterial	20-30	62,671	6,427	1,487	
	Collector		-	-	-	
	Local	15	6,804	699	155	
	TOTAL		69,475	7,126	1,642	1

Seattle - 1977 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
8	Freeway	35-55	147,253	15,085	3,485	
	Arterial	20-25	54,035	5,539	1,277	
	Collector		-	-	-	
	Local	15	7,781	799	189	
	TOTAL		209,069	21,423	4,951	1
9	Freeway		0	0	0	
	Arterial	25-35	65,612	6,727	1,554	
	Collector		-	-	-	
	Local	15	6,471	666	155	
	TOTAL		72,083	7,393	1,709	1
10	Freeway	55	128,915	13,209	3,053	
	Arterial	20-25	67,788	6,949	1,598	
	Collector		-	-	-	
	Local	15	9,690	988	233	
	TOTAL		206,393	21,146	4,884	1
11	Freeway		0	0	0	
	Arterial	20-35	93,506	9,579	2,209	
	Collector		-	-	-	
	Local	15	6,549	666	155	
	TOTAL		100,055	10,245	2,364	1
12	Freeway	50	143,468	14,708	3,397	
	Arterial	20-25	97,114	9,957	2,298	
	Collector		-	-	-	
	Local	15	6,294	644	144	
	TOTAL		246,876	25,309	5,839	1
13	Freeway		0	0	0	
	Arterial	20-25	56,566	5,794	1,343	
	Collector		-	-	-	
	Local	15	2,942	300	67	
	TOTAL		59,508	6,094	1,410	1
14	Freeway		0	0	0	
	Arterial	25-35	76,268	7,814	1,798	
	Collector		-	-	-	
	Local	15	4,618	477	111	
	TOTAL		80,886	8,291	1,909	1

Seattle - 1977 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
15	Freeway	50	164,413	16,850	3,885	
	Arterial	20-25	34,166	3,497	810	
	Collector		-	-	-	
	Local	15	6,149	633	144	
	TOTAL		204,728	20,980	4,839	1
16	Freeway	50	37,551	3,852	888	
	Arterial	25	36,797	3,774	866	
	Collector		-	-	-	
	Local	15	4,940	511	122	
	TOTAL		79,288	8,137	1,876	1
17	Freeway		0	0	0	
	Arterial	25-30	76,879	7,881	1,820	
	Collector		-	-	-	
	Local	15	3,818	389	89	
	TOTAL		80,697	8,270	1,909	1
18	Freeway		0	0	0	
	Arterial	25-35	141,259	14,474	3,341	
	Collector		-	-	-	
	Local	15	4,484	455	111	
	TOTAL		145,743	14,929	3,452	1
19	Freeway	50	146,576	15,018	3,463	
	Arterial	20	59,596	6,105	1,410	
	Collector		-	-	-	
	Local	15	7,271	744	167	
	TOTAL		213,443	21,867	5,040	1
20	Freeway		0	0	0	
	Arterial	25	37,107	3,807	877	
	Collector		-	-	-	
	Local	15	8,924	910	211	
	TOTAL		46,031	4,717	1,088	1
21	Freeway	50	136,541	13,997	3,230	
	Arterial	12-25	258,530	26,496	6,116	
	Collector		-	-	-	
	Local	15	1,510	155	33	
	TOTAL		396,581	40,648	9,379	1

Seattle - 1977 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
22	Freeway		0	0	0	
	Arterial	20-25	74,115	7,592	1,754	
	Collector		-	-	-	
	Local	15	7,592	777	178	
	TOTAL		81,707	8,369	1,932	1
23	Freeway	50	96,104	9,846	2,276	
	Arterial	20-25	101,920	10,445	2,409	
	Collector		-	-	-	
	Local	15	3,841	389	89	
	TOTAL		201,865	20,680	4,774	1
24	Freeway		0	0	0	
	Arterial	20-40	87,113	8,924	2,065	
	Collector		-	-	-	
	Local	15	10,645	1,088	255	
	TOTAL		97,758	10,012	2,320	1
25	Freeway		0	0	0	
	Arterial	25-50	69,986	7,171	1,654	
	Collector		-	-	-	
	Local	15	1,332	133	33	
	TOTAL		71,318	7,304	1,687	1
26	Freeway	60	94,827	9,724	2,242	
	Arterial	25	54,246	5,561	1,288	
	Collector		-	-	-	
	Local	15	2,564	266	55	
	TOTAL		151,637	15,551	3,585	1
27	Freeway		0	0	0	
	Arterial	25-35	86,402	8,858	2,042	
	Collector		-	-	-	
	Local	15	2,975	300	67	
	TOTAL		89,377	9,158	2,109	1
28	Freeway		0	0	0	
	Arterial	25-50	107,148	10,978	2,531	
	Collector		-	-	-	
	Local	15	444	44	11	
	TOTAL		107,592	11,022	2,542	1

Seattle - 1977 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
29	Freeway	50	115,362	11,822	2,731	
	Arterial	25-35	59,352	6,083	1,399	
	Collector		-	-	-	
	Local	15	4,040	411	100	
	TOTAL		178,754	18,316	4,230	1
30	Freeway	55	83,561	8,558	1,976	
	Arterial	25	48,529	4,973	1,143	
	Collector		-	-	-	
	Local	15	4,473	455	111	
	TOTAL		136,563	13,986	3,230	1
31	Freeway		0	0	0	
	Arterial	25-35	64,080	6,571	1,521	
	Collector		-	-	-	
	Local	15	2,620	266	67	
	TOTAL		66,700	6,837	1,588	1
32	Freeway	55	49,972	5,117	1,177	
	Arterial	25	35,576	3,641	844	
	Collector		-	-	-	
	Local	15	2,165	222	55	
	TOTAL		87,713	8,980	2,076	1
33	Freeway	55-60	115,773	11,866	2,742	
	Arterial	35	10,157	1,043	244	
	Collector		-	-	-	
	Local	15	3,474	355	78	
	TOTAL		129,404	13,264	3,064	1
34	Freeway	50	60,773	6,227	1,432	
	Arterial	30	13,220	1,354	311	
	Collector		-	-	-	
	Local	15	1,598	167	33	
	TOTAL		75,591	7,748	1,776	1
35	Freeway	55	70,341	7,204	1,665	
	Arterial	25-35	35,098	3,596	833	
	Collector		-	-	-	
	Local	15	2,442	255	56	
	TOTAL		107,881	11,055	2,554	1

Seattle - 1977 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
36	Freeway	55	41,203	4,218	977	
	Arterial	25	76,879	7,881	1,820	
	Collector		-	-	-	
	Local	15	3,763	389	89	
	TOTAL		121,845	12,488	2,886	1
37	Freeway	55	37,196	3,807	877	
	Arterial	25	37,152	3,807	877	
	Collector		-	-	-	
	Local	15	3,164	322	78	
	TOTAL		77,512	7,936	1,832	1
38	Freeway	55	35,753	3,663	844	
	Arterial	25	8,869	910	211	
	Collector		-	-	-	
	Local	15	3,019	311	67	
	TOTAL		47,641	4,884	1,122	1
39	Freeway	60	50,327	5,162	1,188	
	Arterial	30	13,931	1,432	333	
	Collector		-	-	-	
	Local	15	3,408	344	78	
	TOTAL		67,666	6,938	1,599	1
40	Freeway	60	33,611	3,441	799	
	Arterial	20-25	94,472	9,679	2,231	
	Collector		-	-	-	
	Local	15	2,842	289	67	
	TOTAL		130,925	13,409	3,097	1
41	Freeway	55	79,931	8,192	1,887	
	Arterial	30	10,745	1,099	255	
	Collector		-	-	-	
	Local	15	2,786	289	67	
	TOTAL		93,462	9,580	2,209	1
42	Freeway		0	0	0	
	Arterial	20-45	119,547	12,254	2,831	
	Collector		-	-	-	
	Local	15	2,764	278	67	
	TOTAL		122,311	12,532	2,898	1

Seattle - 1977 - 24-Hour

District	Facility Type	Avg Speed (mph)	VMT			Area (sq. mi.)
			LD	HD	Diesel	
43	Freeway		0	0	0	
	Arterial	25-30	101,920	10,445	2,409	
	Collector		-	-	-	
	Local	15	2,242	233	56	
	TOTAL		104,162	10,678	2,465	1
44	Freeway		0	0	0	
	Arterial	25	65,168	6,682	1,543	
	Collector		-	-	-	
	Local	15	1,865	189	44	
	TOTAL		67,033	6,871	1,587	1
45	Freeway	60	56,022	5,739	1,321	
	Arterial	25	54,401	5,572	1,288	
	Collector		-	-	-	
	Local	15	5,173	533	122	
	TOTAL		115,596	11,844	2,731	1
46	Freeway	60	65,645	6,727	1,554	
	Arterial	25-35	82,795	8,480	1,954	
	Collector		-	-	-	
	Local	15	4,140	422	100	
	TOTAL		152,580	15,629	3,608	1
47	Freeway	60	56,954	5,839	1,343	
	Arterial	25	19,758	2,020	466	
	Collector		-	-	-	
	Local	15	6,205	633	144	
	TOTAL		82,917	8,492	1,953	1
48	Freeway	60	56,377	5,783	1,332	
	Arterial	25	40,182	4,118	955	
	Collector		-	-	-	
	Local	15	7,326	755	178	
	TOTAL		103,885	10,656	2,465	1
	Freeway		TOTAL	TOTAL	TOTAL	VMT Total For All Vehicle Types
	Arterial					
	Collector					
	Local					
	TOTAL		5,745,842	588,793	135,885	6,470,520

APPENDIX B

TABULATIONS OF VEHICULAR EMISSIONS

The computer printout contained in Appendix B provides a breakdown of emissions by vehicle type for the various zones as well as the total emissions for each zone which were presented in the body of the report. 1970 CO emissions for Zones 1-41 are given on page B-2, and 1971 and 1977 CO emissions for Zones 1-50 are given on Pages B-3 and B-4, respectively. Hydrocarbon emissions for Zones 1-41 for these three years are given on pages B-5, B-6 and B-7. CO emissions for Zone 21 (CBD) for years 1972, 1973, 1974, 1975, 1976, 1978, and 1979 are given on pages B-8, B-9, and B-10. 1977 CO emissions for Zone 21 under three strategy combinations are given on page B-11.

CITY OF SEATTLE CALENDAR YEAR IS 1970

REGION NO. 1 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1958 TO 1971

LENGTH OF TIME PERIOD IS 8 HOURS

VEHICLE CATEGORY -		LIGHT DUTY		HEAVY DUTY		OTHER		TOTAL	
ZONE NO.	AREA (SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)
1	1.000	2475.94	2475.94	378.62	378.62	25.86	25.86	2880.43	2880.43
2	1.000	3463.16	3463.16	529.56	529.56	33.94	33.94	4026.66	4026.66
3	1.000	2036.68	2036.68	311.36	311.36	13.08	13.08	2361.13	2361.13
4	1.000	3679.47	3679.47	562.58	562.58	37.47	37.47	4279.52	4279.52
5	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.000	3044.99	3044.99	465.69	465.69	34.00	34.00	3544.68	3544.68
7	1.000	2376.11	2376.11	363.34	363.34	15.41	15.41	2754.86	2754.86
8	1.000	4547.51	4547.51	695.41	695.41	47.53	47.53	5290.45	5290.45
9	1.000	2501.56	2501.56	382.59	382.59	15.86	15.86	2900.01	2900.01
10	1.000	5233.81	5233.81	800.42	800.42	47.23	47.23	6081.46	6081.46
11	1.000	3223.71	3223.71	492.98	492.98	22.43	22.43	3739.13	3739.13
12	1.000	6170.98	6170.98	943.75	943.75	56.21	56.21	7170.93	7170.93
13	1.000	2267.43	2267.43	346.76	346.76	14.49	14.49	2628.67	2628.67
14	1.000	2592.20	2592.20	396.44	396.44	19.59	19.59	3008.23	3008.23
15	1.000	4363.78	4363.78	667.32	667.32	47.39	47.39	5078.48	5078.48
16	1.000	2340.00	2340.00	357.80	357.80	19.19	19.19	2716.99	2716.99
17	1.000	2576.71	2576.71	394.06	394.06	19.43	19.43	2990.21	2990.21
18	1.000	5063.80	5063.80	774.44	774.44	36.31	36.31	5874.55	5874.55
19	1.000	5966.88	5966.88	912.50	912.50	52.80	52.80	6932.17	6932.17
20	1.000	1789.94	1789.94	273.72	273.72	11.04	11.04	2074.70	2074.70
21	1.000	13317.42	13317.42	2036.68	2036.68	88.54	88.54	15442.64	15442.64
22	1.000	3451.60	3451.60	527.86	527.86	20.88	20.88	4000.34	4000.34
23	1.000	5944.58	5944.58	909.05	909.05	49.76	49.76	6903.38	6903.38
24	1.000	3414.34	3414.34	522.18	522.18	24.59	24.59	3961.12	3961.12
25	1.000	1987.98	1987.98	494.44	494.44	17.31	17.31	2499.73	2499.73
26	1.000	3484.85	3484.85	866.73	866.73	34.39	34.39	4385.97	4385.97
27	1.000	2738.61	2738.61	418.77	418.77	22.51	22.51	3179.89	3179.89
28	1.000	2566.82	2566.82	638.43	638.43	25.70	25.70	3230.94	3230.94
29	1.000	4115.54	4115.54	1023.66	1023.66	41.02	41.02	5180.22	5180.22
30	1.000	3409.76	3409.76	521.46	521.46	32.74	32.74	3963.95	3963.95
31	1.000	2019.14	2019.14	308.84	308.84	16.04	16.04	2344.02	2344.02
32	1.000	2259.05	2259.05	345.49	345.49	21.25	21.25	2625.79	2625.79
33	1.000	2298.71	2298.71	351.51	351.51	29.53	29.53	2679.75	2679.75
34	1.000	1549.26	1549.26	236.89	236.89	16.76	16.76	1802.91	1802.91
35	1.000	2414.42	2414.42	369.25	369.25	24.76	24.76	2808.43	2808.43
36	1.000	3846.73	3846.73	588.24	588.24	30.27	30.27	4465.24	4465.24
37	1.000	2258.75	2258.75	345.42	345.42	19.82	19.82	2623.99	2623.99
38	1.000	1110.39	1110.39	169.86	169.86	11.00	11.00	1291.24	1291.24
39	1.000	1265.32	1265.32	193.53	193.53	14.70	14.70	1473.54	1473.54
40	1.000	4036.23	4036.23	617.21	617.21	27.98	27.98	4681.42	4681.42
41	1.000	1705.67	1705.67	260.86	260.86	20.27	20.27	1986.80	1986.80

CITY OF SEATTLE CALENDAR YEAR IS 1971

REGION NO. 2 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1959 TO 1972

LENGTH OF TIME PERIOD IS 8 HOURS

VEHICLE CATEGORY -		LIGHT DUTY		HEAVY DUTY		OTHER		TOTAL	
ZONE NO.	AREA (SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)
1	1.000	2283.92	2283.92	359.01	359.01	25.25	25.25	2668.17	2668.17
2	1.000	3194.54	3194.54	502.09	502.09	33.13	33.13	3729.76	3729.76
3	1.000	1878.75	1878.75	295.26	295.26	12.78	12.78	2186.79	2186.79
4	1.000	3394.08	3394.08	533.35	533.35	36.57	36.57	3964.00	3964.00
5	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.000	2808.82	2808.82	441.49	441.49	33.19	33.19	3283.50	3283.50
7	1.000	2191.83	2191.83	344.55	344.55	15.04	15.04	2551.42	2551.42
8	1.000	4194.79	4194.79	659.33	659.33	46.39	46.39	4900.50	4900.50
9	1.000	2307.53	2307.53	362.72	362.72	15.49	15.49	2685.75	2685.75
10	1.000	4827.86	4827.86	758.87	758.87	46.09	46.09	5632.81	5632.81
11	1.000	2973.67	2973.67	467.38	467.38	21.90	21.90	3462.96	3462.96
12	1.000	5692.37	5692.37	894.71	894.71	54.84	54.84	6641.91	6641.91
13	1.000	2091.56	2091.56	328.75	328.75	14.14	14.14	2434.45	2434.45
14	1.000	2391.14	2391.14	375.88	375.88	19.12	19.12	2786.14	2786.14
15	1.000	4025.33	4025.33	632.66	632.66	46.25	46.25	4704.24	4704.24
16	1.000	2158.54	2158.54	339.25	339.25	18.74	18.74	2516.52	2516.52
17	1.000	2376.85	2376.85	373.64	373.64	18.96	18.96	2769.45	2769.45
18	1.000	4671.04	4671.04	734.20	734.20	35.43	35.43	5440.66	5440.66
19	1.000	5504.09	5504.09	865.10	865.10	51.51	51.51	6420.70	6420.70
20	1.000	1651.15	1651.15	259.51	259.51	10.78	10.78	1921.44	1921.44
21	1.000	12284.45	12284.45	1930.89	1930.89	86.40	86.40	14301.73	14301.73
22	1.000	3183.90	3183.90	500.45	500.45	20.39	20.39	3704.74	3704.74
23	1.000	5483.49	5483.49	861.86	861.86	48.56	48.56	6393.91	6393.91
24	1.000	3149.51	3149.51	495.08	495.08	24.00	24.00	3668.59	3668.59
25	1.000	1833.83	1833.83	468.80	468.80	16.90	16.90	2319.53	2319.53
26	1.000	3214.56	3214.56	821.73	821.73	33.55	33.55	4069.84	4069.84
27	1.000	2526.18	2526.18	397.07	397.07	21.98	21.98	2945.24	2945.24
28	1.000	2367.75	2367.75	605.26	605.26	25.08	25.08	2998.08	2998.08
29	1.000	3796.32	3796.32	970.47	970.47	40.02	40.02	4806.81	4806.81
30	1.000	3145.29	3145.29	494.39	494.39	31.94	31.94	3671.62	3671.62
31	1.000	1862.54	1862.54	292.80	292.80	15.65	15.65	2171.00	2171.00
32	1.000	2083.86	2083.86	327.56	327.56	20.74	20.74	2432.16	2432.16
33	1.000	2120.43	2120.43	333.29	333.29	28.82	28.82	2482.54	2482.54
34	1.000	1429.11	1429.11	224.63	224.63	16.35	16.35	1670.09	1670.09
35	1.000	2227.18	2227.18	350.08	350.08	24.17	24.17	2601.43	2601.43
36	1.000	3548.39	3548.39	557.73	557.73	29.53	29.53	4135.65	4135.65
37	1.000	2083.58	2083.58	327.53	327.53	19.35	19.35	2430.45	2430.45
38	1.000	1024.27	1024.27	161.03	161.03	10.74	10.74	1196.04	1196.04
39	1.000	1167.20	1167.20	183.48	183.48	14.35	14.35	1365.03	1365.03
40	1.000	3723.20	3723.20	585.23	585.23	27.31	27.31	4335.73	4335.73
41	1.000	1573.40	1573.40	247.31	247.31	19.78	19.78	1840.49	1840.49
42	1.000	4905.12	4905.12	769.30	769.30	29.55	29.55	5703.96	5703.96
43	1.000	631.42	631.42	99.03	99.03	4.63	4.63	735.08	735.08
44	1.000	2074.34	2074.34	325.32	325.32	14.59	14.59	2414.26	2414.26
45	1.000	2872.66	2872.66	450.56	450.56	26.72	26.72	3349.93	3349.93
46	1.000	3600.12	3600.12	564.61	564.61	35.57	35.57	4200.30	4200.30
47	1.000	1867.33	1867.33	292.86	292.86	19.72	19.72	2179.91	2179.91
48	1.000	2184.34	2184.34	343.35	343.35	19.80	19.80	2547.49	2547.49
49	1.000	2285.99	2285.99	359.34	359.34	19.68	19.68	2665.00	2665.00
50	1.000	1504.96	1504.96	236.57	236.57	14.74	14.74	1756.26	1756.26

CITY OF SEATTLE CALENDAR YEAR IS 1977

REGION NO. 2 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1965 TO 1978

LENGTH OF TIME PERIOD IS 8 HOURS

VEHICLE CATEGORY -		LIGHT DUTY		HEAVY DUTY		OTHER		TOTAL	
ZONE NO.	AREA (SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)
1	1.000	1370.20	1370.20	408.77	408.77	30.33	30.33	1809.30	1809.30
2	1.000	1850.75	1850.75	544.51	544.51	39.19	39.19	2434.45	2434.45
3	1.000	1035.57	1035.57	276.37	276.37	15.29	15.29	1327.23	1327.23
4	1.000	2022.91	2022.91	595.22	595.22	42.88	42.88	2661.01	2661.01
5	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.000	1624.37	1624.37	495.15	495.15	38.43	38.43	2157.95	2157.95
7	1.000	1169.39	1169.39	312.53	312.53	17.39	17.39	1499.31	1499.31
8	1.000	2369.51	2369.51	706.35	706.35	52.33	52.33	3128.19	3128.19
9	1.000	1122.81	1122.81	305.89	305.89	18.04	18.04	1446.75	1446.75
10	1.000	2518.77	2518.77	733.91	733.91	51.66	51.66	3304.33	3304.33
11	1.000	1570.74	1570.74	427.05	427.05	25.04	25.04	2022.84	2022.84
12	1.000	3102.42	3102.42	896.87	896.87	61.84	61.84	4061.13	4061.13
13	1.000	1018.95	1018.95	271.27	271.27	14.90	14.90	1305.12	1305.12
14	1.000	1175.84	1175.84	326.10	326.10	20.25	20.25	1522.19	1522.19
15	1.000	2213.25	2213.25	669.86	669.86	51.23	51.23	2934.34	2934.34
16	1.000	1059.25	1059.25	300.62	300.62	19.84	19.84	1379.71	1379.71
17	1.000	1170.79	1170.79	324.82	324.82	20.19	20.19	1515.80	1515.80
18	1.000	2230.52	2230.52	610.32	610.32	36.47	36.47	2877.31	2877.31
19	1.000	2651.16	2651.16	769.42	769.42	53.41	53.41	3473.00	3473.00
20	1.000	816.07	816.07	215.50	215.50	11.53	11.53	1043.10	1043.10
21	1.000	6372.44	[illegible]	1707.91	[illegible]	95.78	95.78	8176.13	8176.13
22	1.000	1491.31	1491.31	391.23	391.23	20.45	20.45	1902.99	1902.99
23	1.000	2669.75	2669.75	762.43	762.43	51.13	51.13	3483.32	3483.32
24	1.000	1494.49	1494.49	409.98	409.98	24.47	24.47	1928.94	1928.94
25	1.000	905.67	905.67	260.29	260.29	17.74	17.74	1183.70	1183.70
26	1.000	1589.48	1589.48	776.14	776.14	361.62	361.62	2727.25	2727.25
27	1.000	1202.34	1202.34	340.55	340.55	22.37	22.37	1565.26	1565.26
28	1.000	1153.38	1153.38	559.75	559.75	25.72	25.72	1738.84	1738.84
29	1.000	1931.93	1931.93	934.28	934.28	42.62	42.62	2908.82	2908.82
30	1.000	1602.92	1602.92	472.66	472.66	34.19	34.19	2109.77	2109.77
31	1.000	924.25	924.25	259.66	259.66	16.70	16.70	1200.60	1200.60
32	1.000	1052.68	1052.68	308.27	308.27	21.96	21.96	1382.92	1382.92
33	1.000	1137.89	1137.89	370.08	370.08	32.35	32.35	1540.32	1540.32
34	1.000	772.92	772.92	238.30	238.30	18.92	18.92	1030.14	1030.14
35	1.000	1073.85	1073.85	326.86	326.86	25.29	25.29	1426.01	1426.01
36	1.000	1683.67	1683.67	473.22	473.22	30.47	30.47	2187.36	2187.36
37	1.000	1047.40	1047.40	303.11	303.11	20.98	20.98	1371.49	1371.49
38	1.000	525.66	525.66	158.60	158.60	120.79	120.79	805.05	805.05
39	1.000	661.34	661.34	207.09	207.09	16.94	16.94	885.37	885.37
40	1.000	2121.87	2121.87	573.27	573.27	32.98	32.98	2728.13	2728.13
41	1.000	889.50	889.50	281.15	281.15	23.39	23.39	1194.04	1194.04
42	1.000	2383.14	2383.14	598.41	598.41	30.59	30.59	3012.14	3012.14
43	1.000	333.44	333.44	87.18	87.18	5.08	5.08	425.70	425.70
44	1.000	1142.57	1142.57	295.96	295.96	16.78	16.78	1455.30	1455.30
45	1.000	1484.33	1484.33	414.59	414.59	28.80	28.80	1927.72	1927.72
46	1.000	1862.76	1862.76	529.30	529.30	38.25	38.25	2430.31	2430.31
47	1.000	962.47	962.47	278.65	278.65	20.96	20.96	1262.08	1262.08
48	1.000	1267.49	1267.48	369.41	369.41	26.02	26.02	1662.92	1662.92
49	1.000	1107.52	1107.52	312.86	312.86	20.41	20.41	1440.79	1440.79
50	1.000	747.33	747.33	219.05	219.05	15.63	15.63	982.01	982.01

CITY OF SEATTLE   CALENDAR YEAR IS 1970

REGION NO. 1   POLLUTANT SPECIFS IS HYDROCARBONS

MODEL YEARS CONSIDERED IS FROM 1958 TO 1971

LENGTH OF TIME PERIOD IS   3 HOURS

VEHICLE CATEGORY -		LIGHT DUTY		HEAVY DUTY		OTHER		TOTAL	
ZONE NO.	AREA (SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)
1	1.000	179.86	179.86	33.30	33.30	1.45	1.45	214.61	214.61
2	1.000	243.11	243.11	45.22	45.22	1.91	1.91	290.25	290.25
3	1.000	116.22	116.22	22.18	22.18	0.74	0.74	139.14	139.14
4	1.000	263.40	263.40	48.86	48.86	2.11	2.11	314.37	314.37
5	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.000	229.86	229.86	42.40	42.40	1.91	1.91	274.18	274.18
7	1.000	136.24	136.24	26.00	26.00	0.87	0.87	163.10	163.10
8	1.000	327.03	327.03	60.65	60.65	2.62	2.62	390.30	390.30
9	1.000	141.20	141.20	26.95	26.95	0.89	0.89	169.04	169.04
10	1.000	351.02	351.02	65.58	65.58	2.66	2.66	419.26	419.26
11	1.000	191.11	191.11	36.31	36.31	1.26	1.26	228.69	228.69
12	1.000	416.66	416.66	77.06	77.06	3.16	3.16	496.88	496.88
13	1.000	129.05	129.05	24.63	24.63	0.81	0.81	154.50	154.50
14	1.000	160.43	160.43	30.34	30.34	1.10	1.10	191.87	191.87
15	1.000	323.94	323.94	59.85	59.85	2.66	2.66	386.45	386.45
16	1.000	149.70	149.70	28.14	28.14	1.08	1.08	178.92	178.92
17	1.000	160.37	160.37	30.37	30.37	1.09	1.09	191.82	191.82
18	1.000	308.40	308.40	58.58	58.58	2.04	2.04	369.02	369.02
19	1.000	395.42	395.42	73.96	73.96	2.88	2.88	472.25	472.25
20	1.000	99.91	99.91	19.10	19.10	0.62	0.62	119.63	119.63
21	1.000	718.44	718.44	136.56	136.56	4.73	4.73	859.73	859.73
22	1.000	190.28	190.28	36.42	36.42	1.17	1.17	227.87	227.87
23	1.000	385.25	385.25	72.37	72.37	2.80	2.80	460.42	460.42
24	1.000	208.09	208.09	39.49	39.49	1.38	1.38	248.96	248.96
25	1.000	131.09	131.09	39.96	39.96	0.97	0.97	172.03	172.03
26	1.000	244.01	244.01	73.81	73.81	1.92	1.92	319.75	319.75
27	1.000	177.39	177.39	33.37	33.37	1.27	1.27	212.02	212.02
28	1.000	181.81	181.81	54.95	54.95	1.44	1.44	238.21	238.21
29	1.000	290.95	290.95	87.97	87.97	2.30	2.30	381.22	381.22
30	1.000	236.54	236.54	44.04	44.04	1.84	1.84	282.42	282.42
31	1.000	128.98	128.98	24.33	24.33	0.90	0.90	154.21	154.21
32	1.000	154.65	154.65	28.85	28.85	1.19	1.19	184.69	184.69
33	1.000	193.20	193.20	35.47	35.47	1.66	1.66	230.33	230.33
34	1.000	115.16	115.16	21.30	21.30	0.94	0.94	137.39	137.39
35	1.000	174.33	174.33	32.33	32.33	1.39	1.39	208.06	208.06
36	1.000	241.50	241.50	45.53	45.53	1.70	1.70	288.74	288.74
37	1.000	141.31	141.31	26.50	26.50	1.04	1.04	168.84	168.84
38	1.000	78.50	78.50	14.58	14.58	0.62	0.62	93.70	93.70
39	1.000	97.27	97.27	17.89	17.89	0.82	0.82	115.98	115.98
40	1.000	237.65	237.65	45.10	45.10	1.58	1.58	284.33	284.33
41	1.000	133.99	133.99	24.63	24.63	1.14	1.14	159.75	159.75

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                 CITY OF SEATTLE             CALENDAR YEAR IS 1971

                 REGION NO.  2          POLLUTANT SPECIES IS HYDROCARBONS

                 MODEL YEARS CONSIDERED IS FROM 1959 TO 1972

                 LENGTH OF TIME PERIOD IS    3 HOURS

   VEHICLE
   CATEGORY -     LIGHT DUTY              HEAVY DUTY                OTHER                     TOTAL

ZONE   AREA  EMISSIONS   EMISSION    EMISSIONS   EMISSION    EMISSIONS   EMISSION    EMISSIONS   EMISSION
 NO.                     DENSITY                 DENSITY                 DENSITY                 DENSITY
      (SQ.MI)  (KGM)    (KGM/SQ.MI)    (KGM)    (KGM/SQ.MI)    (KGM)    (KGM/SQ.MI)    (KGM)    (KGM/SQ.MI)

  1   1.000    158.63     158.63       31.18       31.18        1.42        1.42       191.22      191.22
  2   1.000    214.51     214.51       42.37       42.37        1.86        1.86       258.74      258.74
  3   1.000    102.86     102.86       20.92       20.92        0.72        0.72       124.50      124.50
  4   1.000    232.34     232.34       45.74       45.74        2.06        2.06       280.14      280.14
  5   1.000      0.0        0.0         0.0         0.0         0.0         0.0          0.0         0.0
  6   1.000    202.62     202.62       39.64       39.64        1.87        1.87       244.13      244.13
  7   1.000    120.58     120.58       24.51       24.51        0.85        0.85       145.94      145.94
  8   1.000    288.46     288.46       56.79       56.79        2.55        2.55       347.80      347.80
  9   1.000    124.98     124.98       25.41       25.41        0.87        0.87       151.25      151.25
 10   1.000    309.90     309.90       61.52       61.52        2.59        2.59       374.01      374.01
 11   1.000    169.06     169.06       34.21       34.21        1.23        1.23       204.50      204.50
 12   1.000    367.83     367.83       72.28       72.28        3.09        3.09       443.20      443.20
 13   1.000    114.23     114.23       23.24       23.24        0.80        0.80       138.26      138.26
 14   1.000    141.84     141.84       28.55       28.55        1.07        1.07       171.47      171.47
 15   1.000    285.61     285.61       55.99       55.99        2.60        2.60       344.20      344.20
 16   1.000    132.26     132.26       26.45       26.45        1.05        1.05       159.77      159.77
 17   1.000    141.80     141.80       28.58       28.58        1.06        1.06       171.45      171.45
 18   1.000    272.80     272.80       55.17       55.17        1.99        1.99       329.96      329.96
 19   1.000    349.14     349.14       69.39       69.39        2.81        2.81       421.34      421.34
 20   1.000     88.46      88.46       18.02       18.02        0.60        0.60       107.09      107.09
 21   1.000    635.55     635.55      128.60      128.60        4.62        4.62       768.77      768.77
 22   1.000    168.48     168.48       34.38       34.38        1.14        1.14       204.00      204.00
 23   1.000    340.33     340.33       67.96       67.96        2.73        2.73       411.03      411.03
 24   1.000    184.06     184.06       37.20       37.20        1.35        1.35       222.61      222.61
 25   1.000    115.78     115.78       37.52       37.52        0.95        0.95       154.25      154.25
 26   1.000    215.31     215.31       69.15       69.15        1.88        1.88       286.33      286.33
 27   1.000    156.74     156.74       31.37       31.37        1.24        1.24       189.35      189.35
 28   1.000    160.41     160.41       51.48       51.48        1.41        1.41       213.30      213.30
 29   1.000    256.71     256.71       82.41       82.41        2.25        2.25       341.37      341.37
 30   1.000    208.74     208.74       41.28       41.28        1.80        1.80       251.82      251.82
 31   1.000    114.00     114.00       22.88       22.88        0.88        0.88       137.76      137.76
 32   1.000    136.51     136.51       27.06       27.06        1.16        1.16       164.73      164.73
 33   1.000    170.21     170.21       33.13       33.13        1.62        1.62       204.95      204.95
 34   1.000    101.54     101.54       19.93       19.93        0.92        0.92       122.39      122.39
 35   1.000    153.79     153.79       30.28       30.28        1.36        1.36       185.43      185.43
 36   1.000    213.45     213.45       42.81       42.81        1.66        1.66       257.92      257.92
 37   1.000    124.81     124.81       24.89       24.89        1.01        1.01       150.71      150.71
 38   1.000     69.26      69.26       13.66       13.66        0.61        0.61        83.54       83.54
 39   1.000     85.73      85.73       16.73       16.73        0.80        0.80       103.26      103.26
 40   1.000    210.21     210.21       42.48       42.48        1.54        1.54       254.23      254.23
 41   1.000    118.07     118.07       23.02       23.02        1.11        1.11       142.20      142.20
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CITY OF SEATTLE CALENDAR YEAR IS 1977

REGION NO. 2 POLLUTANT SPECIES IS HYDROCARBONS

MODEL YEARS CONSIDERED IS FROM 1965 TO 1978

LENGTH OF TIME PERIOD IS 3 HOURS

VEHICLE CATEGORY -		LIGHT DUTY		HEAVY DUTY		OTHER		TOTAL	
ZONE NO.	AREA (SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)
1	1.000	73.11	73.11	28.17	28.17	1.70	1.70	102.99	102.99
2	1.000	101.38	101.38	38.55	38.55	2.20	2.20	142.13	142.13
3	1.000	46.69	46.69	17.37	17.37	0.86	0.86	64.91	64.91
4	1.000	109.05	109.05	41.67	41.67	2.41	2.41	153.13	153.13
5	1.000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	1.000	89.53	89.53	34.71	34.71	2.16	2.16	126.40	126.40
7	1.000	47.77	47.77	19.70	19.70	0.98	0.98	68.45	68.45
8	1.000	132.60	132.60	50.70	50.70	2.94	2.94	186.24	186.24
9	1.000	52.55	52.55	19.67	19.67	1.01	1.01	73.23	73.23
10	1.000	129.57	129.57	49.62	49.62	2.90	2.90	182.07	182.09
11	1.000	73.21	73.21	27.40	27.40	1.41	1.41	102.01	102.01
12	1.000	160.99	160.99	61.28	61.28	3.47	3.47	225.74	225.74
13	1.000	47.65	47.65	17.60	17.60	0.84	0.84	66.09	66.09
14	1.000	56.78	56.78	21.38	21.38	1.14	1.14	79.29	79.29
15	1.000	124.24	124.24	47.85	47.85	2.88	2.88	174.96	174.96
16	1.000	55.79	55.79	21.00	21.00	1.11	1.11	77.91	77.91
17	1.000	57.01	57.01	21.44	21.44	1.13	1.13	79.58	79.58
18	1.000	106.47	106.47	39.85	39.85	2.05	2.05	148.38	148.38
19	1.000	143.78	143.78	54.46	54.46	3.00	3.00	201.24	201.24
20	1.000	36.08	36.08	13.37	13.37	0.65	0.65	50.10	50.10
21	1.000	292.22	292.22	108.69	108.69	5.38	5.38	406.29	406.29
22	1.000	65.08	65.08	24.06	24.06	1.15	1.15	90.29	90.29
23	1.000	136.63	136.63	51.83	51.83	2.89	2.89	191.35	191.35
24	1.000	71.19	71.19	26.66	26.66	1.38	1.38	99.22	99.22
25	1.000	45.99	45.99	17.52	17.52	1.00	1.00	64.51	64.51
26	1.000	85.85	85.85	53.89	53.89	2.03	2.03	141.77	141.77
27	1.000	60.21	60.21	22.81	22.81	1.26	1.26	84.27	84.27
28	1.000	61.79	61.79	38.72	38.72	1.44	1.44	101.95	101.95
29	1.000	106.94	106.94	66.53	66.53	2.39	2.39	175.86	175.86
30	1.000	85.96	85.96	32.91	32.91	1.92	1.92	120.79	120.79
31	1.000	45.87	45.87	17.32	17.32	0.94	0.94	64.12	64.12
32	1.000	55.84	55.84	21.34	21.34	1.24	1.24	78.41	78.41
33	1.000	72.36	72.36	28.25	28.25	1.82	1.82	102.43	102.43
34	1.000	44.81	44.81	17.32	17.32	1.06	1.06	63.19	63.19
35	1.000	65.07	65.07	25.08	25.08	1.52	1.52	91.68	91.68
36	1.000	83.35	83.35	31.49	31.49	1.71	1.71	116.55	116.55
37	1.000	51.33	51.33	19.52	19.52	1.10	1.10	71.95	71.95
38	1.000	29.36	29.36	11.31	11.31	0.68	0.68	41.36	41.36
39	1.000	38.04	38.04	14.85	14.85	0.95	0.95	53.84	53.84
40	1.000	97.02	97.02	36.28	36.28	1.86	1.86	135.16	135.16
41	1.000	51.83	51.83	20.27	20.27	1.32	1.32	73.42	73.42

CITY OF SEATTLE CALENDAR YEAR IS 1972

REGION NO. 1 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1960 TO 1973

LENGTH OF TIME PERIOD IS 8 HOURS

VEHICLE CATEGORY -		LIGHT DUTY		HEAVY DUTY		OTHER		TOTAL	
ZONE NO.	AREA (SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)
21	1.000	11405.42	11405.42	1898.32	1898.32	86.40	86.40	13390.14	13390.14

CITY OF SEATTLE CALENDAR YEAR IS 1973

REGION NO. 1 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1961 TO 1974

LENGTH OF TIME PERIOD IS 8 HOURS

VEHICLE CATEGORY -		LIGHT DUTY		HEAVY DUTY		OTHER		TOTAL	
ZONE NO.	AREA (SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)
21	1.000	10348.25	10348.25	1974.15	1974.15	86.40	86.40	12308.79	12308.79

CITY OF SEATTLE CALENDAR YEAR IS 1974

REGION NO. 1 POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1962 TO 1975

LENGTH OF TIME PERIOD IS 8 HOURS

VEHICLE CATEGORY -		LIGHT DUTY		HEAVY DUTY		OTHER		TOTAL	
ZONE NO.	AREA (SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)	EMISSIONS (KGM)	EMISSION DENSITY (KGM/SQ.MI)
21	1.000	9253.75	9253.75	1794.64	1794.64	86.40	86.40	11134.79	11134.79

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              CITY OF SEATTLE             CALENDAR YEAR IS 1975

              REGION NO.  1          POLLUTANT SPECIES IS CARBON MONOXIDE

              MODEL YEARS CONSIDERED IS FROM 1963 TO 1976

              LENGTH OF TIME PERIOD IS    8 HOURS

  VEHICLE
  CATEGORY -     LIGHT DUTY            HEAVY DUTY              OTHER                  TOTAL

ZONE  AREA   EMISSIONS   EMISSION   EMISSIONS   EMISSION   EMISSIONS   EMISSION    EMISSIONS   EMISSION
NO.                      DENSITY                DENSITY                DENSITY                 DENSITY
     (SQ.MI)   (KGM)   (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)    (KGM)    (KGM/SQ.MI)

 21   1.000   9414.38    9414.38    1726.02    1726.02      88.74       88.74     10229.14   10229.14




              CITY OF SEATTLE             CALENDAR YEAR IS 1976

              REGION NO.  1          POLLUTANT SPECIES IS CARBON MONOXIDE

              MODEL YEARS CONSIDERED IS FROM 1964 TO 1977

              LENGTH OF TIME PERIOD IS    8 HOURS

  VEHICLE
  CATEGORY -     LIGHT DUTY            HEAVY DUTY              OTHER                  TOTAL

ZONE  AREA   EMISSIONS   EMISSION   EMISSIONS   EMISSION   EMISSIONS   EMISSION    EMISSIONS   EMISSION
NO.                      DENSITY                DENSITY                DENSITY                 DENSITY
     (SQ.MI)   (KGM)   (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)    (KGM)    (KGM/SQ.MI)

 21   1.000   7222.86    7222.86    1697.61    1697.61      91.07       91.07      9011.53    9011.53
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          CITY OF SEATTLE              CALENDAR YEAR IS 1978

          REGION NO.  1          POLLUTANT SPECIES IS CARBON MONOXIDE

          MODEL YEARS CONSIDERED IS FROM 1966 TO 1979

          LENGTH OF TIME PERIOD IS    8 HOURS

   VEHICLE
   CATEGORY -     LIGHT DUTY              HEAVY DUTY              OTHER                   TOTAL

ZONE   AREA   EMISSIONS   EMISSION   EMISSIONS   EMISSION   EMISSIONS   EMISSION    EMISSIONS   EMISSION
NO.                       DENSITY                DENSITY                DENSITY                 DENSITY
      (SQ.MI)   (KGM)   (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)    (KGM)    (KGM/SQ.MI)

21    1.000   5200.05    5200.05    1654.17    1654.17      96.80      96.80      6951.02    6951.02




          CITY OF SEATTLE              CALENDAR YEAR IS 1979

          REGION NO.  1          POLLUTANT SPECIES IS CARBON MONOXIDE

          MODEL YEARS CONSIDERED IS FROM 1967 TO 1980

          LENGTH OF TIME PERIOD IS    8 HOURS

   VEHICLE
   CATEGORY -     LIGHT DUTY              HEAVY DUTY              OTHER                   TOTAL

ZONE   AREA   EMISSIONS   EMISSION   EMISSIONS   EMISSION   EMISSIONS   EMISSION    EMISSIONS   EMISSION
NO.                       DENSITY                DENSITY                DENSITY                 DENSITY
      (SQ.MI)   (KGM)   (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)   (KGM)    (KGM/SQ.MI)    (KGM)    (KGM/SQ.MI)

21    1.000   4285.21    4285.21    1617.13    1617.13      98.70      98.70      6001.04    6001.04
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CITY OF SEATTLE                CALENDAR YEAR IS 1977

REGION NO.  1          POLLUTANT SPECIES IS CARBON MONOXIDE

MODEL YEARS CONSIDERED IS FROM 1965 TO 1978

LENGTH OF TIME PERIOD IS    8 HOURS

                                                ZONE 21
     VEHICLE
     CATEGORY -     LIGHT DUTY           HEAVY DUTY              OTHER                    TOTAL

[illegible] AREA  EMISSIONS   EMISSION  EMISSIONS   EMISSION  EMISSIONS   EMISSION    EMISSIONS   EMISSION
                              DENSITY               DENSITY               DENSITY                 DENSITY
         (SQ.MI)  (KGM)    (KGM/SQ.MI)  (KGM)    (KGM/SQ.MI)  (KGM)    (KGM/SQ.MI)    (KGM)    (KGM/SQ.MI)

        1  1.000  6259.64   6259.64     1678.42   1678.42      94.29      94.29       8032.35   8032.35
    1 + 2  1.000  6135.84   6135.84     1646.21   1646.21      92.66      92.66       7874.71   7874.71
1 + 2 + 3  1.000  5890.02   5890.02     1596.11   1596.11      92.66      92.66       7578.79   7578.79
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